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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

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A Unified Costing Scheme

The importance of establishing for each industry a set of costing principles for Government contract work, agreed upon between Government buying departments and manufacturers, is self-evident. Recognising the truth of this notion, the Internal-Combustion Engine Manufacturers' Association instituted negotiations with the heads of the costing branches of the contracts departments of the Admiralty, Ministry of Supply and Air Ministry, and a cost ascertainment scheme has been agreed upon, which applies to all the large category of Government contracts in which there is a term to the effect that "the contract price shall be a reasonable price to be mutually agreed having regard to costs."

No better argument can be put forth to justify such a scheme than the reasons given for its initiation in a memorandum written by Sir Lynden Macassey, K.B.E., K.C., independent chairman of the Internal-Combustion Engine Manufacturers' Association, as a preface to the exposition of the scheme.

After pointing out that, previous to the establishment of the scheme, cost investigators of the three Government supply departments independently checked costs of *all* contracts based on cost ascertainment, and this without any uniformity of procedure either on the part of the investigators or the members of the Association, Sir Lynden states: "This placed a great strain on the staffs of members of the Association, and with the much increased number of contracts of the class in question with the three Government departments, it was becoming obvious that the staffs could not continue to cope with the procedure involved. In addition the procedure led not infrequently to controversy and, in some cases, in spite of the best efforts on both sides to avoid it, to friction."

Similar difficulties exist, and like controversies are bound to arise, in cases where the foundry industry is directly concerned with contracts placed by Government supply departments which contain the cost ascertainment clause. In present circumstances, not only do the Government investigators use their own methods of costing, which are not even the same in different districts, but foundry managements do not yet establish their costs on standard principles. This must lead to confusion and to divergence of views, accompanied by serious waste of time and effort.

The time is ripe for the foundry industry to approach the heads of the costing branches of the Government buying departments and agree with them on a cost scheme. There is no lack of organised representation of the foundry industry—and in this connection the Ironfounders' National Confederation can play an important part; and the set of costing principles established by the Costing Sub-Committee of the Institute of British Foundrymen can serve as a starting point. Such conditions are favourable for a speedy mutual agreement being reached.

It is interesting to note that one of the objects of the cost ascertainment scheme agreed upon between the three Government departments and the Internal-Combustion Engine Manufacturers' Association is to reduce to a minimum the cases in which investigation of costs will be necessary, and, where necessary, the procedure of investigation. Furthermore, members of the Association are not asked to change their entire cost system, unless the Government investigators consider there is a fundamental error in principle that might result in incorrect costs being arrived at.

Certain principles, however, are requested to be followed:—

(*a*) Direct Materials should be charged at actual costs, including carriage inwards, and not at market price at time of contract.

(*b*) Direct Labour should, wherever possible, be limited to operators' wages only.

(*c*) Works overhead charges are considered as a percentage of *Direct Labour*. It is therefore recommended that members classify the same things as Direct Labour and limit Direct Labour to operators' wages only.

(*d*) Commercial and selling charges should be expressed as a percentage of Total Works Cost.

The scheme comprises examples of *pro forma* statements under the following headings: Annual Audited Balance Sheet and Profit and Loss Account; Summary Profit and Loss Account; Foundries (giving costs of materials, labour, overheads, and value of castings, for iron and non-ferrous metals respectively); Sales; Works Oncost; Works Oncost Recovery; Administration and Selling Expenses; Administration and Selling Oncost Recovery; Special Charges. These statements cover yearly accounts. They are followed by four statements showing the basis on which costs should be prepared: Direct Costs; Works Oncost and Administration and Selling Oncosts; Indirect Labour (which includes cupola and core-oven attendants, painting patterns and the pattern-shop sawyer); and a Summary of Costs per Unit. The whole scheme is quite simple and orthodox.

The Late Mr. Victor Stobie

The death, briefly recorded in our columns last week, of Mr. Victor Stobie came as a profound shock to the very wide circle of friends he possessed. His career, interspersed with some brilliant successes, was essentially individualistic, for he never possessed either partner or co-director. Though he was endowed with extraordinary energy, there were times when he could usefully have delegated some of his work to a partner. Moreover, when he was engaged upon the development of one of his many inventions, meals, sleep and even routine business were forgotten in his enthusiastic search for the novel. Stobie was born in Birmingham, the son of Mr. Thomas Stobie, who for many years was a foreign representative for Thos. Firth & Sons, Limited, of Sheffield. It thus happened that his childhood and youth were spent in Paris. Not only did this bestow upon him bilingualism, but instilled into him some of that Latin logic associated with the French educational system.

By about 1904, he settled in Sheffield and took full advantage of the facilities offered by the evening classes of the local university to acquire a knowledge of metallurgy and electrical engineering. These studies were supplemented by much reading of the work of the pioneer metallurgists, such as Bessemer, Siemens and Percy. The constant references to invention and patents in these early books and Papers caused Stobie to take a deep interest in the legal aspect of such matters, and in this branch of activity his knowledge was so profound that he was generally recognised as a reliable lay expert.

During this period he occupied a minor position with Hobson Houghton & Company, Limited, but concurrently with it he conducted an agency business for a foreign refractory brick. In 1910, he established himself in business as the Sheffield Annealing Works Company, which was probably the first concern to undertake the heat-treatment of steel for the trade. The furnace, of the producer-gas-fired "coffin" type, was of his own invention, and he was successful in selling quite a number of installations to Germany and America.

Realising that there was accumulating in Sheffield considerable quantities of high-speed mill scale, he conceived the idea that it would be profitable to extract the tungsten it contained, but to do this an electric furnace would be an essential. He arranged with Electro-Metals, Limited, of London, for the supply of a furnace based on their patents, but to his own design. The original scheme was never pursued, for all his attention was devoted to the early development of electric-furnace technique. In 1912 he sold the annealing works, and removed his business, now known as the Stobie Steel Company, to Dunston-on-Tyne, where he installed electric furnaces based on his own patents. During the 1914-18 war he not only got this quite sizeable works into full production, but found time to experiment with the production of synthetic white iron, using a pair of stationary electric furnaces, worked duplex. It was during this period that he designed and patented the electrode economiser which effectively eliminated the chimney effect caused by the space between the electrodes and roof of the furnace. Sales of electric furnaces were made to several of the British steelworks, and some time later he supplied an installation for use in connection with sugar beet.

For two decades he gave much attention to working out a system for the stereoscopic projection of cinema pictures. In photographic circles this was acknowledged to be a great technical success, but no commercial exploitation has been undertaken.

Shortly after the war the Dunston works were shut down, and Stobie found time to interest himself in the work of the Institute of the British Foundrymen, of which he had been a member since 1912. His interest in foundry work was more academic than practical, but none the less real. He presided over the Newcastle Branch in 1927 and over the Institute in 1932, when a highly-successful conference was held. Stobie, an effective public speaker, proved himself to be an ideal President. He had no grandiose schemes for making his year a memorable one, but rather was his policy that of consistently raising the dignity of the Institute by every possible means, and especially by the social character of the annual meetings. His enthusiastic interest in the work of the Institute was continuous until the outbreak of this war, somewhat handicapped though he was by residence at Harrogate. His inventive genius now naturally turned to foundry plant, and he produced an electric moulding machine, which eventually found its place in the silicon-carbide industry. His last invention was known as the Sandontap process, which involves the ramming up of moulds by the pneumatic projection of sand through piping.

Stobie devoted much time and energy during the post-war period to the development of a high-frequency electric melting furnace, and a few industrial installations were made. He held membership in the Institution of Electrical Engineers and the Iron and Steel Institute, to both of which, as well as to many other technical bodies, he contributed Papers of outstanding merit.

Stobie possessed an infinite charm, which in Institute circles won him a host of friends, who will join with us in expressing to Mrs. Stobie and his family our very deep and heartfelt sympathy.

Open-Hearth Design*

At the Convention of the Association of Iron and Steel Engineers, held recently at Chicago, MR. W. C. BUELL, JUNR., presented a Paper on "A Survey of Open-Hearth Design," a summary of which is appended.

The Paper deals with the problems of furnace sizes and productive rates and with the effects of design and of the use of different charges and fuels on operations. The modification in productive rates when making different grades of steels is briefly touched upon. The data upon which the Paper was based are largely drawn from answers to a *questionnaire* sent to about 40 plants after the invitation to present the Paper was received, and are therefore entirely up-to-date.

The Paper holds that a shallow bath will produce steel more rapidly than a deep bath against a unit of productive performance, and that as furnaces of smaller capacity may be expected to have less bath depth than the larger furnace, the smaller furnace is the relatively faster producing unit. Fairly convincing data are offered in support of this conclusion.

In advanced practice, silicon is stated to be the metalloid, the oxidation and fluxing of which is a most costly operation. A method of controlling silicon in the metal delivered to the open hearth is suggested. Shops with six or seven furnace units are claimed to be more rapid producers than those with ten or more units in line.

An interesting numerical constant which developed incidental to this study is found in the value "215." By dividing this constant by the time of a heat in hours, the answer must always be "net tons of steel made per 1,000 cub. ft. of metal in the bath per hour." It offers a simple means of comparing with exactitude any phase of open-hearth operation, and should find wide general use.

* "Iron and Steel Engineer."

Random Shots

It would be unfair, having made more than one reference to Christmas greetings cards, to leave out mention of those which have been coming (unavoidably a little late) from friends in America. Very typical of these messages from across the Atlantic is Dr. Jim Mackenzie's, which is at the same time sympathetic and cheering. "I think," he writes, "that the English have done more than their share of the job of disposing of Adolf. We are hoping that Mr. Knudsen, under the new set-up, will see to it that you get some real help from this country. My hope for the New Year is that we can swing this country into line to *give* what it takes to finish the job."

* * *

According to "The Times," the President of the Society of Automotive Engineers, speaking recently at Detroit on the aircraft portion of the national defence programme, said that: "Results may not show yet, because it takes time to get started, but when the plants begin to go they will go very fast." He mentioned the fact that the National Association of Manufacturers is sending out 50,000 *questionnaires*!

* * *

With 50,000 *questionnaires* on the way, "Marksman" cannot help feeling that the war is half won already! Another 50,000 and the war will be won, all over bar shouting.

* * *

In a block of flats where nearly every resident possesses a toy dog, a committee meeting was held to decide whether or not the dogs should be admitted to the air-raid shelter. After much discussion it was finally decided that they would be admitted at the discretion of the warden. The warden thereupon put up the notice: "Any dog who scratches will be deemed to be infected by the Bugbug and will be Bardia."

* * *

An article in a daily newspaper says that "women land-workers number nearly 10,000. It is hoped to increase them to aid the nation's food production."

Cannibals!

* * *

YOUNG SON: Daddy, what does *pièce de résistance* mean?

DADDY (absent-mindedly): Let me see—a high-tensile test-bar, of course.

* * *

The week's metallurgical crossword clue comes from "The Times":—

Clue: Muth Muth.

Answer: Bismuth.

"MARKSMAN."

Diaries and Calendars

We acknowledge with sincere thanks the receipt of a four-day to the page pocket diary, carrying a few pages of technical data, from *Dorman, Long & Company, Limited, of Middlesbrough.*

*British Pigirons, Limited, of Abbey House, Victoria Street, London, S.W.*1, and *"Little Court," Pyrford Common, Woking, Surrey,* have sent us a wall calendar surmounted by a picture by A. L. Grace of a cheery Georgian gentleman giving the loyal toast.

THE Minister of Labour and National Service has formed a new branch of the Ministry to be known as the Engineering Branch to advise on engineering matters, especially in relation to the work of the Munitions Labour Supply Organisation. Mr. G. Stevenson Taylor will take charge of the new branch.

Melting Furnace Practice

PROFESSOR HAY'S ADDRESS TO FALKIRK FOUNDRYMEN

At a recent meeting of the Falkirk Section of the Scottish Branch of the Institute of British Foundrymen, PROF. R. HAY (Royal Technical College, Glasgow) gave an interesting lantern lecture on "Melting Furnaces," with special reference to the cupola. There was a large attendance of members.

The retiring chairman, MR. J. A. DONALDSON, who occupied the chair initially, said his experience in office had been most pleasant, and he desired to express to the committee, and especially to Mr. T. R. Goodwin, the secretary, his grateful thanks for the help and support they had given. Mr. Goodwin, he said, had never spared himself in undertaking tasks which might have been carried out by a more active President than himself. In Mr. Alexander Cunningham (Grangemouth Iron Company), the new chairman of the Section, they had a very able man who had all the characteristics required to make a very successful chairman. In carrying out the season's programme in these times they might be faced with difficulties, but under Mr. Cunningham he was confident that any that did arise would be surmounted. The difficulties would be less if the members regularly attended the meetings and thus supported the office-bearers. He reminded the meeting that Mr. Erskine, one of their members, had accepted the Presidency of the Scottish Branch for the second time, and he urged all the members of the Falkirk Section to support the meetings in Glasgow.

A Changed Outlook

MR. CUNNINGHAM then occupied the chair. He thanked the members sincerely for electing him to the office. He remarked that it was many years since he first attended an Institute meeting. Mr. "X," he remembered, was the lecturer at an early meeting of the Scottish Branch. Mr. Mayer, of Dumbarton, was then particularly prominent, and had much to do with its formation. There was a point which struck him on that occasion, and it might be of interest to the younger members. Mr. "X," the lecturer, seemed to him to be out to advertise his own business. To-day in the Institute they had arrived at a better frame of mind. While their purpose was to secure all the information they could get, they drew the line as far as they could at anyone advertising his own business. From the first meeting he had learned one thing and he had never forgot it. Mr. "X" in his lecture made a special plea in regard to the correct method of gating moulds, and ever since he had found the information given then of great use. No matter who the lecturer was, or how far the subject was removed from one's own practice or experience, there was still something to be learned.

MELTING PRACTICE

PROF. HAY prefaced his lecture by remarking that his subject was actually the choice of the Committee. It is not a subject to which he could bring anything in the way of new knowledge, but he hoped, by speaking upon melting furnaces in general and the cupola in particular, that they might find something of interest in his remarks.

With the aid of lantern slides the lecturer traced the development of smelting furnaces from early times. Primitive furnaces which have been found in Africa and Asia were shown and the simple methods of obtaining the blast illustrated. Reference was made to the utilisation of the water wheel as a means of driving the blast engine and to the work of Dr. Roebuck and Smeaton at the Carron Iron Works, where cast-iron cylinders were first employed in place of leather bellows. These were operated by water power and later by one of Watt's steam engines. It was the introduction of such modern methods of driving the furnace, coupled with the introduction of coke as a fuel, so resulting in much higher temperatures within the furnace itself, that led to the production of cast iron as distinct from the malleable iron of the more primitive furnaces.

The disadvantages of this type of furnace were discussed in so far as the fuel and charge were in intimate contact with each other. Reverberatory furnaces were described with the assistance of lantern slides and such developments as regenerative furnaces, application of powdered fuel, and gas and oil methods of firing were touched upon. An example of the successful application of powdered fuel to melting furnaces suitable for foundry purposes was to be found in the Brackelsberg furnace, whilst the Stein & Atkinson furnace afforded a successful example of an oil-fired furnace for the same purpose.

Rotary and Electric Furnaces

In the early days of the use of powdered fuel, trouble was experienced from the ash of the coal, but if suitable coal was used and crushed to the requisite degree of fineness, no trouble need be experienced from this cause. Both oil and powdered fuel offered advantages in temperature control and should afford ample temperature reserve in the production of alloy cast irons. Reverberatory furnace melting, whilst an improvement on blast-furnace or cupola melting, still permitted of contamination of the product by furnace gases. This might be serious if poor-quality fuels were employed such as a coal or oil of high sulphur content. Crucible melting partially overcame this defect, but the amount of material which could be handled in one melt was limited. The electric furnace completely solved the problem of contamination of the charge and permitted of reasonably large quantities being handled in each charge. Moreover, temperature control was well-nigh perfect, so that it was possible to produce the highest quality of alloy castings by this method of melting. A few typical examples of electric furnace were illustrated on the screen and the chief features mentioned.

Choosing a Furnace

The selection of a furnace for the production of iron castings depended upon many factors in addition to the initial cost. The following were cited as some of the more important: The type of product, whether large castings or small, high-quality castings including alloy cast irons, continuous repetition work on a large scale, or frequent changes in composition such as were necessary in a jobbing foundry, and cost of fuel per ton of iron produced. Figures taken from a Paper* by T. F. Urwin showed the relative cost per therm for various fuels:—

Fuel.	Calorific value.	Cost per therm.	B.T.U. per 1d.	Calculated at
Electricity	3,413 B.T.U. per unit	14.56d.	6,826	1s. 2d. per unit.
Town gas	500 B.T.U. per cub. ft.	4.8d.	20,833	2s. per 1,000 cub. ft.
Fuel oil	19,000 B.T.U. per lb.	1.83d.	54,500	65s. per ton.
Producer gas	150 B.T.U. per cub. ft.	2d.	50,000	3d. per 1,000 cub. ft.
Coke-oven gas	500 B.T.U. per cub. ft.	1.8d.	55,500	9s. per 1,000 cub. ft.
Coke	11,000 B.T.U. per lb.	1.46d.	68,400	30s. per ton.
Coal	13,500 B.T.U. per lb.	0.79d.	126.000	20s. per ton.

* FOUNDRY TRADE JOURNAL, November 17, 1932.

A better idea of the usefulness of different furnaces using different fuels could be obtained from melting costs. Hurst had given a few figures on this subject in a Paper,* and these were cited by the lecturer:—

Comparative Costs for Melting One Ton of Material in £ per Ton.

Crucible furnace	3.564
Cupola furnace	0.74
Oil furnace	1.86
Brackelsberg furnace	0.78
Electric furnace	2.6

Whilst those figures placed the cupola in a very favourable light, they did not give the complete picture. Thus, although the cupola was satisfactory for certain classes of castings, it was by no means so satisfactory when close chemical control had to be exercised to meet rigid specification.

Cupola Practice

The lecturer then went on to discuss certain aspects of cupola practice. The chief function of the cupola was that of a melting apparatus. Therefore the first consideration should be given to the suitability of the coke and the correct method of air supply. In the case of coke attention should be paid to proper size and uniformity. It should be screened to remove smalls and large lumps should be broken down to about 6 in. A reasonably combustible coke was desirable, but the strength factor should be sufficient to withstand the weight of the charge and also torsional forces set up in passing down the cupola. The ash content should be low, otherwise unnecessary loss of fuel was caused by slag formation and also additional lime was required for fluxing. A sufficient volume of air should be supplied to give rise to a zone of intense local combustion so that the iron in passing through it would be heated to a temperature sufficiently high to give the necessary fluidity to the molten product. The high temperature of this zone would not permit of the complete combustion of the coke, *i.e.*, of the formation of CO_2. This might be unfortunate but nevertheless it must be accepted.

Theoretically, when carbon was burned to CO_2, 13,500 B.T.U. were liberated by every 1 lb. of carbon consumed, whereas when the carbon was only partially burned to produce CO, only 4,300 B.T.U. were liberated per 1 lb. of carbon consumed. The desirability of complete combustion was therefore obvious. Unless all the carbon was removed in the process of combustion, a state of equilibrium was rapidly set up between carbon, CO_2 and CO, and, at high temperatures, the CO_2 was practically completely eliminated by the interaction of carbon and CO_2 in producing CO, which reaction occurred with the absorption of heat, and the net result so far as heat produced was concerned was the same as if CO had been produced initially. In order to obtain a high CO_2/CO ratio it was essential to cool the system to a temperature around 400 deg. C. The introduction of secondary air in itself could not alter the ratio except in so far as it cooled the system. It was conceivable that the admission of secondary air in a wrong manner might do more harm than good by increasing the temperature, resulting in a lower CO_2/CO ratio than would otherwise be attainable.

* FOUNDRY TRADE JOURNAL, November 19, 1931.

The method of charging the cupola was another very important factor in successful operation. It was essential that coke and pig-iron be independently charged to form separate layers, and that the thickness of these layers be correct for the given operating conditions. It was the combustion of the coke layer in the combustion zone that produced the necessary heat to melt the layer of pig-iron above it. If too little coke or too much pig-iron were present, then poor results might be expected.

The principal defect in cupola melting was the lack of rigid control over operating conditions resulting in inflexibility in the type of product produced. It was not possible to meet rigorous chemical specifications because of variations in carbon pick-up with temperature and atmospheric variations in the cupola. It was because of temperature control, and to a lesser extent the improved thermal efficiency by being able to obtain complete combustion to CO_2, that furnaces utilising powdered fuel owed their success. Even better results technically could be obtained by using closed melting vessels or employing electric current as the heating medium because the additional important factor of atmospheric control could be obtained. Such methods, however, could only be economically justifiable if the highest quality of castings was being produced.

DISCUSSION

MR. J. A. BROWN (Allied Ironfounders), speaking from the point of view of the managements, remarked that they could not lay too much importance on the value or the usefulness of the lectures such as the Institute was making available to the men in Falkirk. They lived in times of intense competition, which would be even greater after the war than it was at present, and unless they had a personnel that was trained in theory as well as in practice they could not hope to maintain their place in the trade of the world. He thought the Falkirk Section had been very fortunate in persuading Prof. Hay to address them.

The CHAIRMAN said they were grateful to Mr. Brown for coming there as a representative of a directorate. He felt that if the directorates took a real interest in the meetings they would find it to their advantage, because of the encouragement it gave to the members of their staffs.

MR. BLAIR said the lecturer had mentioned that pressure of air in a cupola was not the controlling factor, but volume was. Would the lecturer give an indication of the correct pressures to use under varying conditions?

PROF. HAY said the distribution of the blast was of primary importance and one to be adjusted to differing conditions. There were many other problems also to be considered. It was not purely pressure but rather the correct quantity of air, or in other words the volume which governed conditions. Moreover, there was the size of the coke, and its variation in type; whilst devoid of control there was no guarantee that the coke would descend evenly.

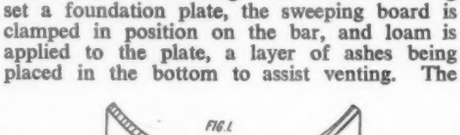
Prof. Hay suggested that one could get a bigger volume of air without the pressure increasing. He also suggested the grading of the fuel as an ameliorative measure.

MR. ROBERT SHAW said that locally they depended on the cupola almost entirely for melting metal. He thought they should pay more attention to other types of furnaces. They might operate a modern furnace more cheaply than the cupola. There was scope for a better type of air furnace. The industry in Falkirk had been adversely affected by the war, and the demand for builders' castings was likely to remain poor until after the war. He realised there was a big demand for castings for the enginering trade, and work in this connection could only be done by a modern type of furnace.

Some Jobbing Foundry Experiences—XVI

By "TRAMP"

An instance where patternwork is built into loam sweeping jobs is illustrated in Fig. 1, which shows an iron mould for producing concave tank ends. The casting is a spherical portion connected to a boss with four arms. The job is cast in the position shown, and the patternwork required is a board as is shown at A, Fig. 2, for the bottom and one as at B for the cope and four arms. These arms are made of well-seasoned timber to avoid distortion when built in contact with the wet loam and are cut ¼ in. clear of the sweeping board. The method of building is as follows: Having set a foundation plate, the sweeping board is clamped in position on the bar, and loam is applied to the plate, a layer of ashes being placed in the bottom to assist venting. The



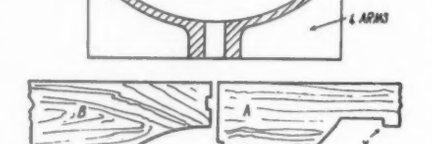


FIG.3

four arms are then set in place by means of a "gap-staff" as shown in Fig. 3. The face of these arms is coated with wet loam, while pieces of dried loam cake are used to make a firm backing behind the loam face. A ring of bricks is then built to form the outside, and the space between the arms and the ring is filled with ashes. Dried loam is used to cover the ashes preparatory to the final sweeping of wet loam by board A. This portion is allowed to stiffen, the board is removed and the arm pattern withdrawn. It is then ready for drying. Meanwhile the cope is struck up on a plate with suitable long teeth to hold the loam. After drying, the mould and cope are rubbed down with sandpaper, blackwashed and assembled by the "feeler" guides.

Industrial Accident Prevention

The Ministry of Labour and National Service, through the National Safety First Association, has sent us specimens of the literature it is disseminating throughout all United Kingdom industrial establishments. The best pamphlet is undoubtedly the "Factory Worker's Safety Code." Every line carries a well-worded message whilst there is commendable freedom from the usual "Don'ts." "Blood Poisoning," a seriously written leaflet, is bound to do much good in industry, especially in respect to the neophytes. The pamphlet carrying the caption, "We Don't Want to Lose You So . . . ." is, in the reviewer's opinion, a rather poor effort. The approach to a reduction in industrial accidents should not be treated in a humorous vein. Finally, there is a *pro forma* letter from the managing director to the various foremen. It takes the form of a leaflet with the letter set out on the outer cover. The twenty-one paragraphs have been well chosen, and by their observance foremen will become more generally efficient, apart from the laudable object of reducing accidents to a minimum.

Base-Mineral Industry of South Africa

With the outbreak of war, the base-mineral industry of the Union of South Africa, as was to be expected, received an initial setback, and trade with enemy countries was brought to a standstill, states the Annual Report of the South African Government Engineer for 1939. Increased freightage charges and other difficulties mitigated against trade with Allied and neutral countries. There are, however, indications that enemy markets are being replaced, and there is a fair prospect of the normal volume of trade being maintained. A pleasing feature since the outbreak of war is the enterprise shown by local industry in its endeavour to replace imported materials by locally produced mineral products, and in this connection every effort is being made to assist in the establishment of suitable sources of supply.

Although exports of chrome ore amounted to the record figure of 187,935 tons, producers operated on a restricted basis. Germany, for several years prior to the war, was an important buyer of South African ore, but fortunately towards the latter part of the year the United States of America increased her purchases, thus partly compensating for the loss of the German market. In the Rustenburg district a plant capable of producing a high-grade concentrate was brought into commission, and in the Lydenburg area a large company was formed to work a large deposit consisting of both friable and hard lumpy ores.

The German market for South African manganese ores has been replaced to a large extent by increased orders from the United States of America and up to June last from France. Producers are, however, experiencing difficulty in disposing of the large tonnages of lower-grade ore produced, due to the prices on offer for this ore and the limited shipping space available. A start has been made in the utilisation of local magnesite in the manufacture of refractory bricks for the iron and steel industry, and there has been an increased consumption for other purposes. Higher prices and increased demand have resulted in increased attention being given to the production of antimony (stibnite) concentrates, tungsten ores, mercury, lead, rare earths and mineral pigments.

Catalogue Received

Grinding Wheels. A most useful booklet, "A Guide to Grinding Wheel Selection," has been issued by the Carborundum Company, Limited, Trafford Park, Manchester, 17. It is of pocket-size and runs to 70-odd pages. The whole subject is first set out logically and progressively. This section occupies 17 pages. Thereafter, up to page 45, tables are given of definite recommendations as to the abrasive, bond, grit and grade for every conceivable kind of job, this last entry being the basis for alphabetical listing. Following this are tables of data covering the grinding and lapping of cemented carbides, operating speeds for grinding wheels, and suitable spindle diameters. Home Office regulations are reproduced—a useful inclusion, and the remainder of the booklet is devoted to data of the conversion table type. This booklet is a really worth-while production, especially under present conditions.

THE PROVISIONS of the Control of Machine Tools (No. 3) and (No. 4) Orders, 1940, have been declared not to apply to sales of used machine tools by auction. No person, however, can sell or agree or offer to sell any used machine tools by auction, except under the authority of the Minister of Supply.

Metallography of Inclusions in Cast Irons and Pig-Irons*

By H. MORROGH (British Cast Iron Research Association, Birmingham)

Introduction

There has been considerable discussion on the effect of inclusions in cast iron, and theories have been put forward implying that these inclusions exert effects on the structural characteristics of this alloy. The majority of these theories have been enunciated without any effort to define the precise meaning of the term "inclusions." The terms "non-metallic inclusion" and "slag inclusion" are more specific in themselves, but throughout the literature both have been used very loosely. The word "inclusion" is used here, not because it is a good one, but rather for lack of a better one and because it is the commonly accepted word for these minor structural constituents. An attempt will be made in this Paper to show how misleading this nomenclature is.

With regard to theories on the effect of inclusions in cast iron and pig-iron, by far the most important are those which postulate their effect on the size and type of graphite formation. The theory put forward by von Keil and his collaborators[1] says that the inclusions are sub-microscopic, while others do not definitely say that the inclusions are either sub-microscopic or microscopic. It is obvious that there can be no direct microscopic metallography of the sub-microscopic inclusions, although Mitsche[2] has examined the possibility of detecting these by means of fluorescence effects.

The process of cataloguing, recognising and tentatively naming the inclusions in plain carbon steels, alloy steels and ferro-alloys by the use of the microscope has been proceeding very rapidly, with the result that a large amount of metallographic information is available in this field. In the case of some inclusions, there is a considerable analogy between steels and cast irons, but in other cases the opposite is the fact. While oxides and silicates are very important inclusions in steels, they are virtually non-existent from the point of view of the metallography of cast iron.

Bolton[3] has suggested that a rough classification of inclusions as foreign and inherent might be made. Foreign inclusions would be entrapped furnace slag, refractories and foundry sand, while inherent inclusions would be small particles inherent in the melting stock or deposited therein by the reaction of alloy additions with elements already in the base iron, or by the reaction of atmospheric or furnace gases with the constituents of the alloy. This preliminary classification seems logical and quite satisfactory. The metallography of the most important foreign inclusions in cast iron has been dealt with previously by the author,[4] and only inherent inclusions will be discussed here.

The effect of foreign inclusions on the inherent inclusions and on the structure of the metal must not, however, be overlooked. In this respect the results obtained recently by Scott and Joseph[5] are interesting. These investigators, using the iodine method for the determination of "non-metallic inclusions," found very much higher silica figures in sand-cast samples than in samples cast in a graphite mould. It has been noted that in the case of cast irons with border-line compositions (that is to say, those which, had they been cast in a slightly larger section, would have solidified grey or mottled), where particles of moulding sand have been included at the edge of the castings, the metal in the immediate vicinity of the inclusion tends to solidify grey. It has also been observed that the presence of such inclusions in irons containing supercooled graphite causes a slight local reversion to the normal flake graphite structure.

A large number of isolated researches have been carried out which are concerned directly and indirectly with inclusions in steels and cast irons, but so far no attempt has been made to draw together the threads of these separate and important researches in a comprehensive manner with respect to cast iron. It is proposed here to consider these researches and to correlate them, wherever possible, with results obtained by the routine microscopic examination of cast irons over a number of years.

Preliminary Scheme of Classification for Inclusions in Cast Irons and Pig-irons

From the points of view of their colour, morphology and chemical constitution, the inherent inclusions in cast irons and pig-irons may be classified arbitrarily into a few groups which greatly facilitate the study of this problem. Such a classification is given below; this was actually drawn up before any experimental work had been done which subsequently indicated that inclusions in different groups in the present classification might be grouped together solely according to chemical constitution. However, it has been used here because it provided the basis on which the constitution and mode of formation of the inclusions were investigated. It is realised that the classification does not, in itself, solve the ultimate identity of the inclusions concerned.

Group I.—Manganese sulphide, iron sulphide and composite inclusions of these two.

Group II.—Pink Inclusions:—

(*a*) Red-pink and idiomorphic.
(*b*) Blue-pink and allotriomorphic.
(*c*) Blue-pink and idiomorphic.

Group III.—White or faint grey inclusions:

(*a*) Idiomorphic.
(*b*) Allotriomorphic.

Group IV.—Inclusions produced by alloying with zirconium.

Group V.—Inclusions produced by alloying with aluminium.

The various groups of inclusions are dealt with in detail in the next section. In the course of the preparation of this Paper, experiments were performed to elucidate some of the problems raised by a critical consideration of the literature and by routine observations. The details and results of these experiments are also given.

METALLOGRAPHY OF THE INDIVIDUAL INCLUSION GROUPS

Group I.—Manganese Sulphide, Iron Sulphide and Composite Inclusions of These Two

It is convenient to deal, in this section, with both iron sulphide and manganese sulphide. These inclusions are very well known, and it is generally recognised that the dove-grey idiomorphic inclusions in cast irons are manganese sulphide, and that the khaki-coloured inclusions, present in irons having low manganese contents, are iron sulphide. In commercial materials the effects of manganese and sulphur are intimately connected. Information regarding these inclusions is to be found in three lines of investigation:—(*a*) Descriptive metallography of the mode of occurrence of the inclusions; (*b*) study of systems relevant to these inclusions, for instance, the systems Fe-S, FeS-MnS, Fe-FeS-MnS-Mn, Fe-S-C, Fe-S-P, etc.; and (*c*) consideration of the facts known about the desulphurising action of manganese.

Much purely metallographic work has been done on manganese and iron sulphide inclusions, equilibrium diagrams pertaining to systems connected with them have been extensively investigated, and many investigations have been performed and much theory has been propounded on the desulphurising action of manganese.

In irons which are completely free from manganese, the sulphur is in the form of iron sulphide (FeS). Additions of manganese to such irons result in the disappearance of iron sulphide, owing to the formation of manganese sulphide. The reaction may be represented by the following equation[6 7]:—

$$FeS + Mn = MnS + Fe.$$

In order to neutralise all the sulphur as manganese sulphide, it is necessary to have an excess of manganese over the theoretical percentage indicated by the formula (MnS). This fact is due to the reversibility of the reaction, as was originally suggested by Baykoff,[8] and confirmed experimentally by Herty and True[9]:—

$$FeS + Mn \rightleftharpoons MnS + Fe.$$

In irons (or steels) containing insufficient manganese to neutralise the sulphur entirely as manganese sulphide, the dove-grey manganese sulphide occurs associated with the khaki iron sulphide in the form of duplex inclusions.

Factors in Sulphur Reduction

It has been shown by numerous investigations[6 10 11 13] that additions of manganese to cast irons and steels promote the removal of sulphur, owing to the rising of manganese sulphide. The extent of desulphurisation was shown by Heike[10] to be proportional to the manganese content and inversely proportional to the temperature. The process of desulphurisation by manganese can be attributed to two main factors. First, additions of manganese cause the above reaction to proceed to the right and, secondly, owing to the very slight solubility of manganese sulphide in molten cast iron and its low relative density, the solid sulphide so formed rises to the surface of the metal. Correspondingly, the effect of the temperature is manifest in two ways. At higher temperatures the reaction tends to proceed more to the left, with a decrease in the concentration of manganese sulphide and an increase in the concentration of iron sulphide,[14] which is very soluble in molten cast iron. Although manganese sulphide is only slightly soluble in molten iron, its solubility does increase appreciably with increasing temperature,[15] thus limiting the extent of possible desulphurisation.

Herty and Gaines[16 17] found that in ladles of molten iron the equilibrium between manganese and sulphur can be expressed by the product Mn per cent. × S per cent. = K. The product was found to vary within the limits 0.03 at 1,100 deg. C. and 0.656 at 1,440 deg. C.

Wohrman[18] prepared synthetic sulphide inclusions in pure iron melts. He gave an extensive and very thorough description of the morphology and mode of occurrence of iron and manganese sulphide in the samples obtained. It is interesting to note that this investigator found large, well-formed dendrites of manganese sulphide in the metal at the tops of the melts containing this inclusion.

Andrew and Binney[19] investigated the solubility of iron and manganese sulphides in solid steels. They concluded, as a result of their experiments, that iron sulphide may be retained in solution in iron by rapidly chilling the metal and that a deposition of iron sulphide occurs on

* Paper prepared for presentation to the Iron and Steel Institute.

reheating the alloy to a temperature of 900 deg. C. They were unable to show manganese sulphide to be soluble in solid iron.

Relative Solubilities

Andrew, Maddocks and Fowler[20] investigated the partial systems manganous-oxide/manganese-sulphide, manganous-silicate/manganese-sulphide, and ferrous silicate/manganese-sulphide. The diagrams given by them for these systems are of the simple eutectiferous type and indicate manganese oxide to be appreciably soluble in solid manganese sulphide at room temperature and manganese and ferrous silicates only slightly so.

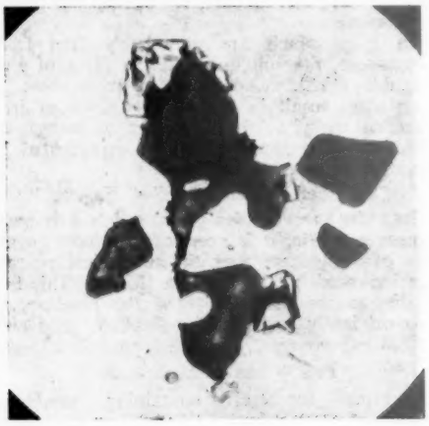


FIG. 1.—MANGANESE SULPHIDE (ASSOCIATED WITH TITANIUM CARBIDE) WITH LIGHT GREEN SPOTS. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 1,200.

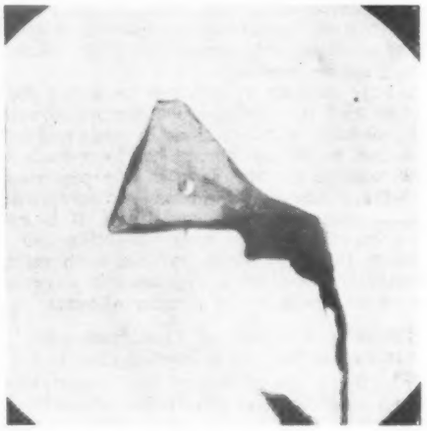


FIG. 2.—MANGANESE SULPHIDE, SHOWING WAVY INTERFERENCE LINES. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 1,000.

The iron-sulphur-oxygen system,[21] the iron-sulphur-carbon system[22 23 24] and the iron-sulphur-phosphorus system[25] have been investigated and shown to exhibit miscibility gaps in the liquid state. In the first system, the miscibility gap extends from the iron/iron-oxide side into the ferrous sulphide corner of the triangle. In the two latter systems, the miscibility gaps extend from the ferrous-sulphide/iron-carbide and from the ferrous-sulphide/iron-phosphide sides into the iron corners.

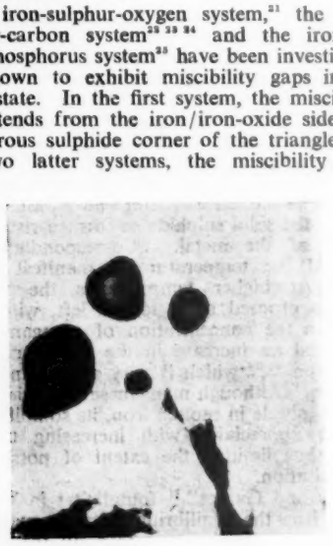


FIG. 3.—MANGANESE SULPHIDE SHOWING LIGHT GREEN COLORATION. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 1,200.

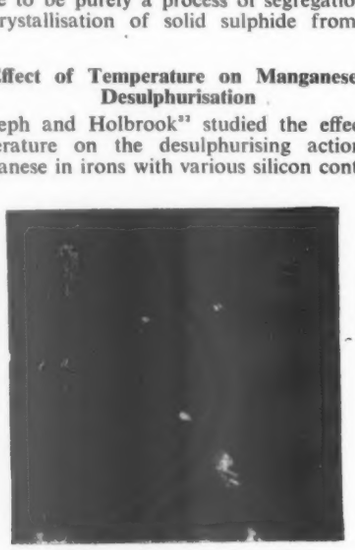


FIG. 4.—SAME SPOT AS FIG. 3 UNDER POLARISED LIGHT BETWEEN CROSSED NICOLS.

The system Fe-FeS-MnS-Mn has been investigated[22 26 27 28] and equilibrium diagrams have been drawn up for this system, showing a miscibility gap which extends from the manganese/manganese-sulphide side far into the iron corner. Wentrup[29] summarised and closely analysed all the published information pertaining to this system. Additions of manganese to the iron-sulphur-carbon system were shown by Satô[30] to extend the region of liquid immiscibility and so promote desulphurisation. In his own experimental work Wentrup studied the effect of carbon, silicon and phosphorus on the extent of desulphurisation. Previously some indirect evidence on this subject had been obtained by Daeves[31] in a statistical study of silicon, phosphorus, manganese and sulphur analyses of pig-iron from three blast furnaces. He found that with increasing silicon or phosphorus contents the sulphur contents fell. Wentrup observed that an increase in the amounts of carbon, silicon or phosphorus favoured an increase in the extent of manganese desulphurisation. This investigator also pointed out the desulphurisation of pig-iron by manganese to be purely a process of segregation by the crystallisation of solid sulphide from the melt.

Effect of Temperature on Manganese Desulphurisation

Joseph and Holbrook[32] studied the effect of temperature on the desulphurising action of manganese in irons with various silicon contents. In presenting the data, the effect of temperature was related to the product Mn per cent. × S per cent. The results indicated that the product was fairly constant at the same temperature, and, when plotted graphically against the temperature, the points so obtained fell approximately on a smooth curve. The results of Joseph and Holbrook are given in Table I.

Shibata[14] investigated the partial system FeS-MnS and produced an equilibrium diagram for this system. Very pure materials were used. It was found that the system gave a simple binary eutectic of two solid solutions at 93.5 per cent. iron sulphide and 6.3 per cent. manganese sulphide at a temperature of 1,164 deg. C. At the eutectic temperature, the iron-sulphide-rich solid solution was found to dissolve 2.0 per cent. of manganese sulphide and the manganese-sulphide-rich solid solution to dissolve 75 per cent. of iron sulphide. On cooling to room temperature, the mutual solubility of these two compounds decreased, so that the α solid solution would only dissolve 0.5 per cent. of manganese sulphide, and the β solid solution 24.0 per cent. of iron sulphide. For the melting point of iron sulphide, Shibata obtained the value 1,173 ± 2 deg. C., and for pure manganese sulphide the value 1,610 ± 3 deg. C.

Influence of Temperature on Solid Solubility

Whiteley[33] heat-treated and quenched samples of steel containing 0.19 per cent. of manganese and 0.019 per cent. of sulphur. The original steel showed both iron and manganese sulphide, but the heat-treatment experiments indicated that at temperatures below 1,000 deg. C. the iron sulphide was gradually dissolved in the manganese sulphide until by heat-treating at 1,150 deg. C. for 5 min. the iron sulphide disappeared completely. The results obtained by Whiteley were in agreement with the requirements of the equilibrium diagram for the system FeS-MnS proposed by Shibata. This diagram indicated, as pointed out previously, that the solubility of solid iron sulphide in solid manganese sulphide decreases rapidly with fall in temperature. By a further experiment Whiteley was able to show that, at temperatures above the solidus, the sulphide consisted predominantly of FeS. The appearance of iron sulphide at these temperatures is due to the fact that the reaction FeS + Mn $\rightleftharpoons$ MnS + Fe will tend to proceed towards the left at higher temperatures. By very drastic quenching from the liquid state, this investigator was able also to show that iron sulphide was present in liquid steel containing 0.06 per cent. of sulphur and 0.6 per cent. of manganese.

When examined with a dry objective, manganese sulphide presents the typical uniform dove-grey colour. When this constituent is examined with an oil-immersion or a monobromo-naphthalene-immersion objective, it appears much darker, with a definite greenish coloration, and occasionally exhibits translucency. This latter property is manifested by the occurrence of light greenish-yellow spots and sets of coloured wavy lines, suggestive of interference phenomena, on the surface of the inclusions. A typical example of the greenish-yellow spots is illustrated in Fig. 1, while Fig. 2 illustrates the occurrence of the coloured wavy lines. In cases where the manganese/sulphur ratio is low and the sulphide inclusions consist of manganese sulphide containing dissolved iron sulphide, the colour under oil-immersion objectives is light dove-grey, without

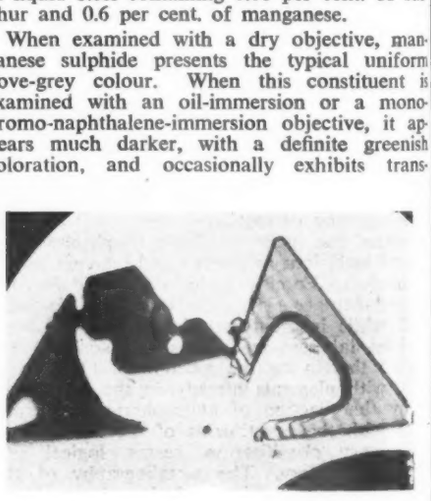


FIG. 5.—THIN WEDGE OF MANGANESE SULPHIDE WITH INTERFERENCE LINES. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 1,200.

any greenish appearance, and the translucency effects are not marked, and in some cases are not even detectable.

Crystal Structure of MnS

Manganese sulphide has a cubic crystal structure,[34] and, as would be expected, inclusions of this compound remain dark in all positions of the stage when they are examined under polarised light between crossed nicols.[35] When, however, a crystal showing light green spots or a set of wavy lines is examined in this manner, a greenish coloration is observed which persists in all positions of the stage. This coloration makes the outline of the inclusion somewhat indefinite. The fact that it appears in all positions of the stage indicates that the brightness is not an effect due to anisotropy. This is an agreement with the crystal structure of manganese sulphide.

When the inclusion is spherical or approximately spherical, and also shows these light green spots under normal bright-field vertical illumination, then examination under polarised light between crossed nicols reveals an optical cross and greenish concentric rings. The more nearly spherical the inclusion is, the more definite does this optical formation become. A nearly spherical manganese sulphide inclusion is shown in Fig. 3. This inclusion had a light green coloration in its centre under bright-field vertical illumination, and when examined under polarised light between crossed nicols the optical cross and concentric rings were clearly developed. This latter point is illustrated in Fig. 4. To the left of the spherical inclusion is one more irregular in outline, but also showing a greenish coloration. In the micrograph taken under polarised light, it is seen that the optical-cross and concentric-ring formations are not so clearly defined in this inclusion as in the spherical one.

Dayton[36] showed that spherical, transparent isotropic inclusions manifest the optical-cross and concentric-ring phenomena when examined under polarised light between crossed nicols. The position of the dark cross remains constant on rotating the stage of the microscope, the arms of the cross being parallel to the planes of polarisation of the incident light and the analyser nicol. Further, Dayton showed that these phenomena are due to the production of circularly polarised light by reflection in isotropic media. These facts lead to the conclusion that the above observations indicate manganese sulphide to be transparent to green light. It would thus appear that the greenish spots seen under ordinary vertical illumination are due to the fact that some of the incident light is transmitted by the inclusion, reflected at the inclusion-metal interface, and transmitted back through the inclusion to the microscope objective. The transmission of light by the inclusion results in the absorption of all wavelengths other than the green or yellow-green. The green coloration seen under polarised light between crossed nicols is due to the production of elliptically polarised light by reflection at the base of the inclusion. The transparency of manganese sulphide also explains the wavy lines. These lines exhibit all the colours of the spectrum, and it would seem that they are interference bands produced by the interference of light reflected from the surface of the inclusion with light reflected from the base of the inclusion. It is obvious that the inclusion must be very thin for this to occur and, in general, it must be wedge-shaped. Fig. 5 illustrates this latter point. The manganese sulphide crystal showing the interference lines appears to be a thin wedge which increases in thickness from right to left.

From the review of the literature on the mode of occurrence of manganese sulphide and on the desulphurisation of iron by manganese, it is seen that, in general, the following facts emerge: Manganese sulphide is only slightly soluble in molten cast iron, the solubility increasing with increasing temperature. At any given temperature, any excess manganese sulphide will tend to rise and segregate at the surface of the molten metal. On cooling from such a specified temperature, the dissolved manganese sulphide will be deposited in a dendritic form. These points are entirely confirmed by the observed morphology of manganese sulphide in cast irons.

(To be continued.)

TABLE I.—*Effect of Temperature and Manganese Content on the Precipitation of Manganese Sulphide from Pig-Iron (Joseph and Holbrook[32]).*

Sample no.	Mn.* Per cent.	S. Per cent.	Temp. Deg. C.	Mn per cent. × S per cent.
Test 91 (silicon 1.2 per cent).				
1 ..	1.81	0.322	1,527	0.583
2 ..	1.77	0.318	1,493	0.563
3 ..	1.63	0.216	1,460	0.352
4 ..	1.56	0.153	1,408	0.238
5 ..	1.48	0.089	1,349	0.132
6 ..	1.39	0.064	1,315	0.089
Test 92 (silicon 0.84 per cent.).				
1 ..	2.13	0.199	1,489	0.424
3 ..	2.05	0.116	1,399	0.238
4 ..	1.97	0.045	1,331	0.089
Test 93 (silicon 1.0 per cent.).				
1 ..	1.18	0.41	1,485	0.484
2 ..	1.01	0.30	1,413	0.303
3 ..	0.80	0.16	1,358	0.128
4 ..	0.70	0.11	1,320	0.077
5 ..	0.66	0.086	1,263	0.057
6 ..	0.66	0.067	1,249	0.044
Test 94 (silicon 0.90 per cent.).				
1 ..	2.90	0.139	1,452	0.403
2 ..	2.84	0.084	1,395	0.238
3 ..	2.74	0.042	1,325	0.115
4 ..	2.70	0.032	1,247	0.086
Test 95 (silicon 3.4 per cent.).				
1 ..	1.31	0.355	1,465	0.465
2 ..	1.05	0.182	1,408	0.191
3 ..	0.96	0.125	1,363	0.120
4 ..	0.89	0.087	1,320	0.077
5 ..	0.86	0.072	1,291	0.062
Test 100 (no slag on metal).*				
1 ..	1.61	0.12	1,455	0.193
2 ..	1.64	0.07	1,390	0.116
3 ..	1.61	0.04	1,294	0.065
4 ..	1.58	0.027	1,243	0.043
5 ..	1.57	0.021	1,234	0.033
Ingot ..	1.56	0.032	—	0.050
Test 101 (metal covered with typical blast-furnace slag).*				
1 ..	1.66	0.058	1,432	0.096
2 ..	1.64	0.035	1,424	0.057
3 ..	1.59	0.030	1,359	0.048
4 ..	1.62	0.027	1,327	0.044
5 ..	1.65	0.027	1,277	0.045
6 ..	1.62	0.023	1,261	0.037
Ingot {	1.52	0.024	—	0.036
	1.52	0.023	—	0.035

* Temperature of bath was measured with a noble-metal thermocouple.

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(Continued in next column.)

War Conditions' Effect on S.A. Steel Industry

ISCOR EXTENSIONS

Iscor's position as a fundamentally economic undertaking has now been established, it was claimed at the annual meeting of the South African Iron & Steel Industrial Corporation, Limited, held at Pretoria on November 27. The chairman, Dr. H. J. van der Bijl, in presenting the balance-sheet for the year ended June 30, 1940, said that the manufacturing profit was £1,168,902, as compared with £1,189,434 for the previous year.

The directors had decided on the construction of a third blast furnace at Pretoria, partly as a standby for the two existing furnaces, and partly to increase the pig-iron output, which would in turn increase the steel-ingot capacity by 150,000 tons. This new blast furnace was already well in hand, the bulk of the work being carried out in Iscor's own shops. Under present conditions the work would probably take one year. Normally the output capacity of the local steel industry represented only about one-third of South Africa's requirements. Therefore the directors had for some time been considering the question of increasing by still further extensions, both the volume of local production and the range of products manufactured. The extensions contemplated included an up-to-date wireworks to produce all commercial grades of steel wire and the erection of a new steelworks in the neighbourhood of Vereeniging. The chairman said that war conditions had necessarily delayed action on these developments, but plans were being prepared and work would be undertaken as and when practicable.

War Demand for Steel

In reviewing sales, the chairman mentioned that the total of all products despatched had been 365,909 tons, and the value £3,928,831. The sales of coke-oven by-products had amounted to 17,595 tons, with a value of £132,137. The foundry pig-iron market had largely been supplied by African Metals Corporation, Limited, from its Newcastle blast furnace, which had also been meeting local requirements of ferro-manganese.

Normally South Africa imported about two-thirds of her steel requirements, mainly from Great Britain and the European continent. The interruption of overseas supplies had resulted in a rush of orders for domestic steel far exceeding the local steel industry's capacity. To keep control of the situation a rationing scheme had been developed which had had the effect of maintaining supplies of steel for urgent purposes and avoiding dislocation of business due to shortage of steel supplies. To prevent more serious steel shortages steps had been taken to import supplies from Australia, Canada and U.S.A. The Union's war effort in producing munitions, mechanical transport vehicles, hangars, camps, etc., had only been made possible by the presence of Iscor.

(Continued from previous column.)

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Soft Solders and Fluxes

By C. W. HART*

Solders and soldering fluxes are usually small items in the cost of components but they serve important purposes. Many firms now have soldering jobs outside their usual experience, sometimes involving problems of temperature or corrosion resistance which require specialist knowledge to solve.

Tinman's Solder

In hand and machine soldering, the main requirement is ease of application, and this demands a solder having a low melting point, good running properties and ability to tin other metals readily and to make a strong joint. Alloys containing about 50 per cent. of tin and 50 per cent. of lead have always been preferred for such work.

Tin additions to lead progressively lower the melting point, and, similarly, lead additions to tin lower the melting point of the alloy. The composition of tinman's solder is quite near the eutectic. As a result, the alloy melts easily and rapidly and has excellent fluidity in the molten state. These properties are of great value in bit and machine soldering.

The ability of a solder to "tin" other metals is improved by high tin content and low melting point; these attributes are well combined in tinman's solder. It is as well to remember that slower soldering, increased difficulty and higher consumption are to be associated with alloys of lower tin content—factors which often offset the initial saving.

Table I shows the strength of some tinman's solders.

TABLE I.—*Physical Properties of Tinman's Solders.*

B.S.S. grade.	Deg. C. at which melting commences.	Deg. C. at which alloy is completely molten.	M.S. Tons per sq. in.	E. Per cent.
A	183	186	4.9	20
B	183	205	4.4	67
C	183	230	4.1	63
E	183	210	3.8	69
F	183	184	4.0	52

Grades B and C contain a small proportion of antimony which improves the properties for most purposes. The antimony content must be carefully controlled during manufacture, however, or the solder will be sluggish and brittle. For certain duties, particularly the soldering of zinc, it is desirable to use an antimony-free solder such as Grade F.

Solders for Dipping Work

The corrosion resistance and bright appearance of soft solders, together with their ability to tin other metals at low temperatures, account for their widespread use as coatings applied by "hot dipping." To obtain consistently satisfactory results, the procedure must be carefully standardised. Factors such as the preliminary cleaning of the articles, the flux used and the temperature of the dipping bath vary with the metal being dipped and the solder used. A covering flux for the solder bath is often advantageous, as it prevents undue oxidation and loss of metal. Periodical analysis of the solder is advised to maintain the composition of the bath and to check contamination resulting from constant dipping of brass and copper.

Soft Solders for High-Temperature Service

All tin-lead solders commence to melt at 183 deg. C., but they begin to lose their strength at lower temperatures. Thus the strength of a joint in brass made with tinman's solder is reduced by 75 per cent. when the temperature is raised to 150 deg. C. For soldered parts subjected to temperatures over 100 deg. C. it is advisable to use a special solder having superior resistance to elevated temperatures. Two types of alloy are available.

The tin-rich alloy H.T.3 melts at 236 deg. C. and has operated satisfactorily at temperatures above the melting point of the ordinary lead-tin solders. The solder is easy to apply, being free-flowing, and can be used to replace tin-lead solders without any change being made in the soldering technique. It is especially recommended for electrical work since it has a high electrical conductivity and can be used with safety fluxes.

The lead-silver solders L.S.1 and L.S.2 have an even bigger advantage in temperature resistance, since they do not commence to melt until the temperature reaches 305 deg. C. They call for rather more experience and skill than normal solders as they do not possess the free-running properties of the tin-containing alloys. They should be used in conjunction with an active flux such as "Frysol." Among the applications in which the above solders are employed are radiators and header tanks, hot-water appliances and electrical machinery.

Lead-Free Solders.—For certain types of work, particularly the soldering of food containers and the tinning of high-quality bearings, it is necessary to use a solder entirely free from lead. Special alloys are compounded to cover these requirements.

Solders for Aluminium

Aluminium is difficult to solder as it readily forms a skin of oxide which is not affected by ordinary fluxes. The old method of soldering aluminium involved vigorous scraping of the surface underneath the molten solder to remove this oxide. The recently-developed "Fryal" solder has greatly simplified the tinning process, scraping being often unnecessary, and mere rubbing of the solder on the heated metal being sufficient to produce a tinned coating. To prevent the joint from corroding, it should be protected, for example, by paint or enamel.

Fusible Solders

Alloys having melting points lower than that of the lead-tin eutectic (183 deg. C.) have been long used in safety devices. Fusible plugs for boilers, cut-outs for electric kettles and fuses for automatic sprinklers may be mentioned. There is a range of low-melting-point alloys available. One of the most popular, Fry's No. 2 fusible alloy, has a melting point of 70 deg. C and so will melt in boiling water.

Two alloys call for special mention. Fry's tube-bending alloy is used in the forming of thin-walled tubes. This alloy is melted in hot water, and poured into the tube, which is plugged at one end. When the filling is cold, the tube is bent into shape. The filling alloy is very ductile and provides the internal support necessary to prevent the tube from distorting or flattening. The tube is finally emptied by melting out the alloy in hot water. The alloy can, of course, be used over and over again.

Matrix alloy is used for the setting of dies and punches in press tools. The die is placed in position by hand and the matrix alloy poured around it. The alloy expands on solidification and so holds the part firmly in position. The low temperature of application ensures that the die is not softened. By this means, considerable saving of time can be obtained compared with the usual machining methods.

* Fry's Metal Foundries, Limited

Soldering Fluxes

Despite the importance of the subject, little reliable information has previously been published on soldering fluxes. It is now recognised that some fluxes which were regarded, and in some cases described, as non-corrosive have in fact sufficient corrosive action to make them unsuitable for much important work. It is very necessary to distinguish clearly between active and non-corrosive fluxes.

(*a*) *Protective or safety fluxes* have little chemical activity, and therefore limited cleansing action. The value of these fluxes lies in their freedom from acid or corrosive action, and they are therefore suitable for electrical, radio and delicate work. "Alcho-re" in fluid or paste form has the widest application. It is a non-conductor and dries very rapidly. The flux residue is harmless and need not be removed.

(*b*) *Active fluxes* represent the ordinary fluxes used for sheet-metal and general soldering work. They are very speedy in action, and there are few metals which cannot be soldered by their use. The flux residue may cause corrosion, and should be removed after soldering by wiping and washing. "Frysol" active fluxes are supplied in fluid, salt or paste form.

A third group includes special fluxes for stainless steel, Monel, nickel, aluminium bronze, zinc, etc.

Tinning Compounds and Creams

By combining an active flux with powdered solder, a compound is obtained which is far more effective than flux and solder separately applied. The compound is simply applied to a heated surface. The activity of "Fryolux" compound is illustrated by the ease with which it forms an adherent tinned coating on dirty, greasy or rusty metal, or on difficult metals such as stainless steel, cast iron and even aluminium.

"Fryolux" cream similarly contains flux and powdered solder. It is applied with a brush and provides an extremely convenient tinning method. One of the advantages of the cream (and, of course, the powder) is that the constituents do not separate, and do not require stirring or mixing before or during use.

Electrolytic Manganese

Electrolytic manganese had its inception in work of the U.S. Bureau of Mines. The Electro Manganese Corporation undertook to commercialise this work in October, 1938, and a plant designed to produce 5,000 lbs. a day was completed in May, 1939. The first attempts at production were unsuccessful, due to a failure in the translation of laboratory results into large-scale operation, states K. M. LEUTE, president of the Corporation, in "Metal Progress." Within a few months these difficulties had been sufficiently corrected to permit the production of 200 to 300 lbs. per day. Operation and improvement have since been practically continuous, so that production is now in excess of 2,000 lbs. per day and is being further augmented. Total production to date has been approximately 300,000 lbs. of 99.9 + per cent. manganese metal, in the form of cathode chips (broken sections of the brittle cathodes, ¼ to ½ in. thick) packed in 250-lb. steel drums. Prices are now competitive with manganese metal from electrothermal or aluminothermic processes, while its quality definitely exceeds these 96 to 98 per cent materials.

Electric Normalising Furnace

An electric furnace having approximate internal dimensions of 12 ft. by 6 ft. by 6 ft. has been erected at one mine in the Johannesburg district, for the purpose of carrying out the annealing of skip and cage connections as required by Mine Regulations, mentions the Annual Report for 1939 of the South African Government Mining Engineer. The furnace is entirely automatic in operation, being fitted with thermostats for temperature control as well as a number of recording pyrometers for providing a record of the temperature in various parts of the furnace during use.

The Foundryman and the Metallurgist

By F. DUNLEAVY

(*Continued from page 26.*)

Domestic foundry problems are being straightened out a little more each day. The metallurgist, with his pencil and paper, is contributing greatly to render the job so much easier by making it systematic and accurate. Perhaps the greatest point is that an accurate record is being kept for all time of the work done and the method used in doing that work. After all, the final sound casting is what all are working for, and there is an old saying: "Count each day lost when the setting sun sees castings sold for cost or business done for fun."

Both foundryman and metallurgist have something each can give the other, and both will benefit by a real understanding of the other's problems.

To all young metallurgists the author would say: "Do not regard the practical foundryman as being devoid of common sense or intelligence." And to the foundryman: "Do not imagine the metallurgist is interfering; the foundry is his natural home, and by co-operation almost anything can be accomplished."

To quote the words of Laing and Rolfe in their preface to the first edition of "A Manual of Foundry Practice":—

> "Operation by the old rule-of-thumb methods, coupled with ignorance or even distrust of the scientific aspects of the subject, is an expensive business. It involves reliance upon opinion rather than upon fact. It means working by methods of trial and error, and it may necessitate the casting of difficult work several times over, before getting it right. It is, in effect, something like trying to sail a vessel to America, without sun, stars or compass, relying only upon the various members of the crew, each of whom thinks that the continent is in an entirely different direction."

There is still a tremendous amount of work for foundrymen to do, and if they were to enter deeply into the question, they would agree that as individuals they are in the position of knowing very much less about the foundry problems and their origin, than they know of their solution.

Nevertheless, if all the knowledge and experiences of the members of the Institute of British Foundrymen were to be pooled, they could—and probably would—solve the majority of foundry troubles, and provided these experiences were recorded accurately, the foundryman would be almost in the same enviable position as certain other departments in the engineering industry.

This point was realised by the Institute when they formed the Technical Committee, with the various sub-committees which cover every branch of the foundry, and, what is more, present to the members an accurate record of the work done.

Introduction of Author

The BRANCH-PRESIDENT (Mr. W. Holland), in introducing the lecturer, said that the members welcomed an old friend and ex-member of the Lancashire Branch. Mr. F. Dunleavy would read a Paper entitled "The Foundryman and the Metallurgist," which was certain to evoke a considerable amount of discussion. The author had been looking forward to presenting it, as he entertained a high regard for the opinions of the Lancashire Branch members.

Vote of Thanks

MR. A. L. KEY proposed a vote of thanks to Mr. Dunleavy for his Paper.

MR. J. JACKSON, in seconding, observed that Mr. Dunleavy had certainly opened a wide field for discussion. It certainly indicated that technology, coupled with practical experience, was the ideal for which they all ought to strive.

The vote of thanks was carried with acclamation.

MR. DUNLEAVY, in responding, said that, unfortunately, he had only had sufficient time to deal with three or four problems, but he hoped that others would be mentioned during the discussion.

DISCUSSION

MR. ABE JACKSON (who was unable to be present) sent a written contribution to the discussion, which was read by the President. He wrote as follows:—"Practice proves that in the vast majority of foundries the metallurgist is neither necessary nor essential, though it may be agreed that to have a metallurgist of experience at one's elbow would be most desirable. All the Institute meetings prove the value of some metallurgical control. Every foreman is aware that he is expected to know something about metallurgical subjects and render at times metallurgical first-aid."

MR. DUNLEAVY said that the contribution appeared to contradict itself. He (the speaker) referred to assistance and not control, but Mr. Jackson apparently wanted a metallurgist at his elbow, but did not want metallurgical assistance. It seemed that he wanted an ornament.

The Size Factor

MR. S. BROOKS, remarking that he had to hunt with the hare as well as the hounds, suggested that the question of the appointment of a metallurgist primarily depended upon the size of the firm. Whether the foundry was small or large and wealthy, from the point of view of British foundrymen it was still a foundry, and as such must be classified in the same group. During the course of his experience he availed himself of every opportunity which presented itself of visiting any foundry, and it was astonishing to find, even to-day, how many people could still make good castings without the direct assistance of a metallurgist. He thought that the theory which obtained, in many instances, was that by buying good brands of pig-iron and good scrap, a good casting could be made.

In the case of a small foundry, where perhaps the owner or a partner was actually working, the proprietors obviously could not afford to employ a metallurgist. The work of such a scientist was highly specialised, and presumably fairly highly paid. When the author stated that he had received much assistance from his metallurgist, this was all the more fortunate from the point of view of the smaller foundryman, who obtained the benefit of that metallurgist's assistance through Mr. Dunleavy and others passing on information which had been methodically obtained. Nevertheless, perhaps members would appreciate the fact that when Mr. Dunleavy acknowledged how useful he found his metallurgist to be, and rightly so, it might be disheartening to the smaller man who could not afford to incur the necessary expense of such assistance.

An Essential Service

MR. DUNLEAVY thought that Mr. Brooks' remark that he had to hunt with the hare and the hounds was interesting, but it was very likely the impression was founded on an illusion; after all, in the Paper he went to some length to point out that the main aim to be achieved was a sound, machined and tested casting. Therefore, the case was not of running with the hare and the hounds. There might be two hares, but they were going to one goal; and criticism and assistance could be taken from whatever line was available.

There was the view that the size of a foundry was a main consideration whether it was possible to afford a metallurgist or otherwise. He claimed that the metallurgist was as essential as the office clerk. If it were necessary to record the sales, it was as necessary to record the material which was being used, how it was being used, and why it was being used.

It was well known that the foundry did not exist in which it could be asserted that it had a perfect staff. There was always some service defective, and they could always do with two or three more helpers to obviate this. The foundryman, for several years, had been expected to possess knowledge which was never included in his training. Perhaps his hearers had had some experience of examining replies to advertisements. A man of 22 would reply to an advertisement for the appointment of a foundry foreman, and would claim he had wide experience in a particular class of work, and that he had knowledge of estimating. It was ridiculous to make a statement that estimating was amongst his qualifications. The foundryman was sufficiently busy with purely foundry matters. He had to face up to that fact, and the sooner he did so the better, for it was useless to try to do another man's job as well as his own. Large and small foundries alike had their troubles; with the large foundry, those troubles would be multiplied. The foundryman should not be asked to make a decision on a point for which he had had no adequate training. Men were available nowadays who had received a scientific training. In the past the foundryman had been expected to wave a magic wand to accomplish successful results; but this was impossible.

Undisclosed Records

A MEMBER, endorsing the lecturer's remarks because he was similarly placed, said that Mr. Dunleavy was not specifically advertising the metallurgist, but was insisting that the services of such a scientist were essential. Moreover, it was now necessary to co-operate with the metallurgist in order to produce modern munitions. As the speaker had gained experience from working in different foundries, eventually becoming associated with a modern one, he realised the accuracy of what the lecturer had stated, namely, that whilst it was not practicable to have a chemist in a small foundry, it was advisable for large foundries to avail themselves of such services. The firm with which he himself was associated employed a chemist and found his services indispensable. Unfortunately, the records of his work were not usually distributed, and one suggestion he would make was that suitable charts should be exhibited in the foundry.

MR. DUNLEAVY said that if the metallurgist was approached in a proper manner and asked for a report, he would certainly comply with the request. Personally, he had a record supplied of everything the metallurgist did in connection with the foundry. It was not so much a case of secrecy as whether the foundryman desired to have a report. It was essential that the foundry should have the assistance of the metallurgist, and it was also necessary that reports should be available to the foundryman, because without such co-operation the services of the metallurgist could easily be dispensed with. It was his reports which guided the foundryman along the road to progress.

The MEMBER agreed, but added that after the metallurgist had obtained accurate figures only conclusions of a general type were passed on to the foundryman. The metallurgist thus secured the leading position. The speaker was not thereby condemning the metallurgist, who was a great asset to the foundry industry.

Wasters and the Metallurgist

MR. W. N. COOK agreed that it was advisable for a foundry to employ a metallurgist, but he thought that Mr. Dunleavy was painting too rosy a picture. When all the factors were controlled, then satisfaction would ensue. However, Mr. Dunleavy must have experienced wasters in the past, he would probably have them in the future, and they would no doubt persist as long as a foundry existed. Who finally took the responsibility for a waster? It was not the chemist's fault, and it was not the foreman-moulder's fault.

Foundry work was becoming more and more scientific in its character. In certain cases of big foundries working with synthetic sands under certain given conditions, a very high percentage of saleable castings was obtained; nevertheless, even the most meticulously controlled foundry did not obtain 100 per cent. good ones. There were always numbers of variables in the foundry which were becoming more and more under control. If one could reach the ideal stage when the mould could be controlled, then one would also reach the point when a foreman-foundryman would not be needed. All factors would be recorded and stipulated, and universal satisfaction given.

Not Metallurgical Work

Mr. Dunleavy had mentioned that the metallurgist sent a lad to do certain work. For many of the records, the foundryman could instruct a lad of his own to take them. Was the lad mentioned by the lecturer a specially-trained youth? The current tendency, which in the future would become even more pronounced, was for foundry executives to employ people of better education than formerly. If the foundry employed boys of good education, instead of the industrial misfits which obtained in some cases, the executive would find that the lads would take an interest in the work. Foundry work was usually a dirty job, and much could be done to make it a clean one.

The metallurgist was very useful, undoubtedly, but many of the jobs Mr. Dunleavy mentioned were certainly not necessarily metallurgist's jobs. However, there was apparently nobody else to do them, and thus the firm provided the services of a metallurgist.

When working with the semi-rotary furnace for non-ferrous metal, there was not much margin for error and a lapse would ruin the metal. With a crucible, the margin was wider. To obtain a good casting when using rotary furnaces required much skill, and the composition of the metal must be carefully controlled.

Incidence of Wasters

MR. DUNLEAVY said that a main point of Mr. Cook's remarks concerned the roseate picture of no wasters. The case in every foundry was that there were always some wasters. He wished to emphasise that the main bulk of the wasters which occurred in any foundry concerned detailed types of castings. There were not many in the 15- to 20-ton range, but there were in castings weighing from a few ounces up to 1 lb., and in the case of medium castings up to 3 or 4 cwts.

As to who took the responsibility for wasters, unfortunately it was the foundry, as obviously the foremen of the fitting or machining shops could not be held responsible.

MR. W. N. COOK knew that the foundry was primarily responsible, but who accepted the responsibility when there was an inquest in the foundry?

MR. DUNLEAVY said that was ascertained after the inquest had been held. He made a practice, every day, of touring the machine shop. If low-carbon content was the trouble, then it was booked under that head. If the fault was due to foundry scrap, then all that was required was the application of a little common sense in order to locate the trouble. It was not difficult to make a dividing line between the laboratory and the foundry. They did not, however, make any bookings against the laboratory, because they were only too glad to have its assistance.

The lad who had been referred to was getting on for 20 years of age, and had been trained ever since leaving school, working through the foundry and then returning to the laboratory, and, every time the opportunity arose, returning to the foundry again. He was receiving a specialised training. When a boy came into the foundry he was taught to mould; when one entered the laboratory he was taught the elements of metallurgy. The minds of the two boys ran in entirely different channels. The youth referred to had done much spade work in compiling figures for the metallurgist's work and reports. He certainly did his work very well. What it was desired to obtain were actual facts of the case, and they were fortunate in being able to receive them.

A point had been raised concerning rotary and crucible furnaces. If one had to use crucibles, there would be an insufficient supply of metal for the shop; if it were possible, they would use them. They could get rid of the metal so rapidly that it was the ideal practice, given very careful control.

Rotary Furnace Costs

MR. F. A. HARPER observed that, in describing the rotary furnaces, Mr. Dunleavy had mentioned interesting figures concerning the speed of melt. Could he state the metallic losses, the total cost of melting per ton of metal (including the metallic losses), the fuel consumption per ton, wear and tear of furnace linings, and labour?

MR. DUNLEAVY replied that there was 2 per cent. metallic loss, but with a new lining the figure varied widely. A certain amount of the charge would soak into the lining. Then, later, when the slag formed inside the furnace, a mixture or an alloy was put in with a much higher melting point, and this would draw the previous alloy out of the lining, resulting in an over-weighted melt. This was a difficulty. He had some high-duty iron which he wanted specially to melt. It was put in almost at the end of the life of the lining, yet gunmetal was dispersed throughout the whole casting; fortunately, the charge was not large, and the castings successfully passed through the fettling shop.

About 14 galls. of fuel per hour were used for each furnace from a cold start. The first 10 cwts. were finished in an hour from cold, and the next 10 cwts. would be melted in three-quarters of an hour. On the day's continuous running they could melt 15 cwts. per hour quite comfortably.

The average life of the furnace lining was approximately 500 heats. The end one shown in Fig. 5 of the Paper had attained 368. Instead of holding 10 cwts., it would now hold 15 or 16 cwts. By the time it was at the end of its life it would probably hold 18 cwts.

The labour was provided by two men. Actually, it was a one-man job; but lately near the furnaces there was a centrifugal-casting machine for spinning liners. One man was put on spinning liners for two or three weeks, since he became accustomed to the settings for the furnace control equipment. The work was of a routine character, for as soon as the melter had put in a charge, he prepared the next one. It was largely a matter of charge wheeling.

MR. HARPER remarked that about four years ago Mr. A. Logan wrote a Paper dealing with the furnace costs. If he remembered rightly, in those days the melting cost per ton ranged from 24s. 6d. to as much as 42s. 6d. in the various forms of furnace melting. Had Mr. Dunleavy any figures showing the cost per ton?

MR. DUNLEAVY said they could be supplied.

Nomenclature

MR. D. FLEMING said that the dictionary defined a metallurgist as "one who was skilled in the art of fabricating or extracting metals"—in other words, anyone connecting with the extraction of the metal from the ore or the production of the job. Therefore, the whole of the members of the Institute, whether they liked it or not, appeared to be metallurgists. The essential difference between the metallurgists mentioned by Mr. Dunleavy and the ordinary foundryman was that Mr. Dunleavy's metallurgist started life in the laboratory and not in the foundry. He was taught to think of facts only, and in a particular way; or, on the other hand, he was trained to think of rather than to do a given job. He acquired specialised knowledge, probably, in analysis, and how far he went after that depended upon the branch of the industry in which he became interested. Probably the problem in the foundry industry to-day was to some extent that the field of work had become so large that no one man was capable of dealing with all its aspects. There was greater complexity, and there was a much more widely extended knowledge of the nature and properties of metals. There was a greater appreciation of the fact that each particular section of the industry was dependent upon the assistance of all the other sections. Otherwise, it would seem to be necessary for the foundryman to be a trained metallurgist, a trained patternmaker and a trained engineer. In other words, he would have to be a "Jack-of-all-trades" in a very complex world. He would not be losing wasters or anything else if someone else studied particular aspects of any particular job.

Co-operation Essential

Some mention had been made of secrecy. Personally, he had no desire to keep any secrets, and he thought the attitude of foundrymen frequently was that they were not anxious to explain their side of the case. The chemist was sometimes treated as a sort of odd-man about the place, and therefore he clung to what bits of information he could acquire. It was desirable that there should be a spirit of open confidence evinced on the part of everybody. It was not a question of the foundryman *versus* the metallurgist; it was merely the problem of whether they were willing to go the whole way with each other and put all their cards on the table, or whether they were inclined to maintain their position merely as two ordinary people.

MR. DUNLEAVY was grateful to Mr. Fleming for his contribution to the discussion. Hitherto the foundryman had "taken the can back" for everybody. If the metallurgist was prepared to co-operate, he would be an asset; if he was not, he would be a burden. He could make himself essentially useful in a foundry producing any grade of castings. He knew from his own experience that the statement was made that the metallurgist was a burden that the foundryman carried on his back; but this was not the

(*Continued on page* 44.)

Installation and Care of Belt Transmissions

By J. GORDON PEIRSON

Great progress has been made, and much ingenuity displayed, in the design of belt transmissions of all kinds, be they of rope, cotton, hemp, manilla, wire rope, balata (used as a coating for canvas), rubber, raw hide or rubberised canvas; additionally there are chain transmissions, including those of special design to give a variable gear ratio on the one pair of sprockets. Tanned leather still holds its own, and is, in fact, considered by many engineers to be superior for most purposes. A great deal of research has been carried out into the best kinds of leather for belt drives, including methods of cementing and preserving them under adverse conditions of use.

Where numerous small machines are in operation running from a single source of power, which is now usually an electric motor, the belt drive, with a system of "fast" and "loose" pulleys, admirably serves the desired purpose in circumstances where any other form of drive (such as chain) would involve unnecessary complications. As a belt drive depends entirely upon friction between the material of the belt and the metal of the pulley, it follows that when a horizontal drive is effected with the tension on the lower side, any sagging of the upper part increases the arc of contact with the pulley, and so adds to the grip.

Thus long belts are, generally speaking, more efficient than short ones, athough wide belts are not so effective on horizontal drives as narrow ones. In the case of a vertical belt drive the catenary effect is, of course, entirely absent. The changes which occur in the belt-drive tension may be controlled artificially by "jockey" pulleys, and it is found that such idlers increase the mean apparent capacity when applied to the *slack* side of the belt.

Pulleys and their Transmission Values

Four general types of pulleys are in common use, *viz.*, cast iron; split steel or wood; paper fibre, and soft-wood rim pulleys with cast-iron hub and spokes. Ordinary belt pulleys have convex faces; those used for rope have tapered grooved rims or flanges. In some cases the ordinary belt pulley face is covered with leather, or has cork inserts to increase the grip. As to the transmitting values, the following are the approximate values using cast-iron pulleys as a basis: soft-wood rim, the same as cast iron; split steel, 5 to 10 per cent. more than cast iron; split wood, 5 to 10 per cent. less; leather-covered, 25 per cent. more, and paper fibre, 15 to 20 per cent. more.

With regard to the correct "crown" of pulleys, there is a wide variance of opinion, but the following are satisfactory under most conditions except vertical drives: Faces 20 in. wide and over, $\frac{1}{16}$ in. per ft., and faces below this $\frac{1}{8}$ in. per ft. On vertical drives the crowns have to be twice and even three times these heights in order to keep the belt running on the pulleys. On vertical drives the weight of the belt tends to make it hang away from the lower pulley so that the arc of contact is materially reduced. When there is a small pulley below a large one, the capacity may be reduced by half. Thin wide belts are better on vertical drives.

Selection of Belt

The selection of a leather belt for a given transmission should not be haphazard. Too frequently it is left to a shop handyman. That individual may judge the width of the belt by the pulley face, which may result in an output loss of 5 per cent. or more, whereas a well-designed belt drive should not involve a greater loss due to the belt than 1 to 1½ per cent. The proper practice is to have the pulley face 6 per cent. wider than the belt to be run on it.

The weight of the belt which should be used on different kinds of drives, and the relation of belt thickness to pulley diameter, must be carefully considered. It is best to use pulleys of large diameter, thus obtaining a high speed. If one or both of the pulleys be exceptionally small and the distance between centres be short, the belt will have difficulty in carrying the load and will slip and burn, as well as having undue strain on the belt joint. Such a fundamental consideration is often overlooked.

Woven belts may be used up to 60 in. wide if necessary. They combine the two essentials of strength and flexibility, and are resistant to moisture, temperature changes, and the attack of chemical fumes, and may be used in outdoor work. There are, however, leather belts which possess these desirable qualities (the practical waterproof leather belt being now a reality), and, as indicated earlier, leather belting will in most cases give service second to none.

In selecting a leather belt of the correct weight or thickness for a pulley of given diameter, the following may be considered as a guide:—

Single Belts.—$\frac{5}{32}$ in. thick, 5 in. dia. pulley; $\frac{7}{32}$ in. thick, 6 in. dia. pulley.

Double Belts.—$\frac{1}{4}$ in. thick, 6 in. dia. pulley; $\frac{5}{16}$ in. thick, 9 in. dia. pulley; $\frac{3}{8}$ in. thick, 14 in. dia. pulley.

Three-ply belts should not be operated on pulleys less than 30 in. dia. With regard to pulley centres, belts up to 4 in. wide should be run on pulleys at 5- to 10-ft. centres; 4 to 8 in. wide for 10- to 15-ft. centres; 8 to 24 in. wide for 15- to 25-ft. centres; 24 to 36 in. wide for 25- to 30-ft. centres; and 36 in. and over for 30- to 40-ft. centres. It is not advisable to use belts at greater than 50-ft. centres, as the belt is likely to sway too much between the pulleys, and therefore possibly come off them.

Measuring for Belts

For endless belts the best procedure is to measure the exact distance around the pulleys with a steel tape. If the drive will not permit the belt being put on endless, ascertain the exact steel-tape measurement around pulleys and add the length of lap required—do not deduct for stretch, but couple up on the job. When cutting a length of belt from a roll for making up and putting on endless, obtain the correct measurement around the pulleys, deduct ¼ per ft. for stretch, and add the length of laps. The length of laps recommended is as follows:—

Width of belt. In.		Length of end laps. In.
Under 4	Single belts	4
4 to 6	" "	6
6 to 10	" "	8
Over 10	" "	12
Under 5	Double belts	8
5 to 12	" "	12
12 to 24	" "	as width
24 and over ..	" "	"

The following rules apply for finding the lengths of belts when a tape cannot be used. (The diameters of pulleys and the centre distances must be in inches or feet consistently.):

(1) *When Pulleys are nearly the Same Size.*—Multiply half the sum of the diameters by 3.14; then add twice the distance between the centres of the shafts.

(2) *When Pulleys are of Widely Different Diameters.*

(*a*) Multiply half the sum of the diameters by 3.14.

(*b*) Multiply the distance between the centres by 2.

(*c*) Square the difference in diameters of the two pulleys, and divide by four times the centre distance. Then add (*a*), (*b*) and (*c*).

(3) *For Crossed Belts.*

(*a*) Multiply half the sum of the pulley diameters by 3.14.

(*b*) Square half the sum of the diameters. Add the square of the centre distance. Subtract the square root of the sum and multiply by 2. Then add (*a*) and (*b*).

The horse-power of leather belting = $\frac{T \times W \times F}{33{,}000}$, where T = effective tension per in. of width; W = width of belt in in.; F = belt speed in ft. per min.

The width of belt required to transmit a given h.p. = $\frac{33{,}000 \times \text{h.p.}}{T \times F}$

Speed and Tension

Contrary to general opinion, a good leather belt, on a well-designed transmission, will transmit maximum power up to between 6,000 and 8,000 ft. per min., but for a reasonably long life the most economical speed is between 3,000 and 5,000 ft. per min. High speeds may be employed on small transmissions for dynamos, but increased speed brings with it centrifugal effects which at some limiting speed result in the driving power of the belt becoming nil.

With regard to the correct tension of a belt, in spite of all special tools and instruments, considerable judgment is still required. A belt can be installed with a greater tension on a self-aligning bearing than it can on a rigid pillow-block bearing, and on a large-diameter shaft as compared with a small one. It is therefore unwise to install a belt at the recognised tension for a given width without taking into due account the mechanical conditions of the drive, and the nature of the load. The best tension is that at which the belt will carry its load easily without straining and with a maximum of journal friction. All leather belts should be operated just as slack as possible without slipping. With an intermittent load, however, it is sometimes necessary to have a fairly high tension.

The key to success with any belt drive, be it open, crossed or quarter-turn, is proper alignment. The ideal is an open horizontal drive with the slack on the top. A horizontal drive with the slack on the bottom requires a belt at least 10 per cent. wider than in the former case.

In crossed belt drives which can be run in one direction only, it is not advisable to cross belts greater than 10 in. in width. The two-pulley quarter-turn, although useful, generally gives most trouble. It is essential on this drive that the pulleys be so placed that the points of leaving on the two pulleys are plumb. If a belt over 5 in. wide is required for this drive, it must be specially made with regard to whether it is to be a right- or left-hand quarter-turn. In a four-pulley quarter-turn, one pulley is usually arranged as a tightener to take up slack. The three-pulley, or two-pulley with idler quarter-turn, has the advantage that it can be reversed. This drive must be arranged so that the point of leaving on the driven pulley is plumb in line with the point of receiving on the driving pulley or *vice versa*. In the case of reverse drives

without crossing it is best to arrange such a drive so that the pull is on the driven pulley and not on the idlers. This eliminates much bearing trouble.

Direction and Side to Run Belts

In the case of a leather belt that is frequently shifted, as on the step cones of lathes, it is good practice to have the edges of the belt rounded so as to protect the laps and plies against opening by the scraping of the shifting forks. With regard to the direction to run leather belts, single ones should be put on with the grain, or hair side, next to the pulleys, and so that the points of the laps will run against the pulleys, because if the laps are on the outside of a belt they are likely to come apart when the points are run against the atmospheric pressure. Double belts should be put on so that the points of the laps run with the pulleys, as both sides point in the same direction. Double-ply and three-ply belts should have laps with male and female ends. Although there are many ingenious metallic fasteners, which have the advantage that they are easily fixed (with the aid, however, of special tools) it is generally much better to cement the joint—which is a simple operation—or to lace the ends.

Considerable controversy has arisen over the question as to whether the flesh or the grain side of a leather belt is the best for driving. After years of practical research and experimentation, however, it has been proved that the grain side next to the pulleys will pull a load 20 to 40 per cent. greater than the flesh side, depending on the type and design of drive. The grain side takes a little bit of "running in," but it improves with use, whereas the flesh side does the exact opposite. In the case of double-ply and three-ply belts the grain side is always against the pulleys.

The specially tanned leather used in the manufacture of belting has a tensile strength of 3,000 to 5,000 lbs. per sq. in., or 750 to 1,500 lbs. per sq. in. of width. In actual use, however, the tension is far below these figures, and is usually between 160 and 330 lbs. per sq. in., or 30 and 80 lbs. per inch width. Undue tension results in stretching. It is interesting to note that the strength of a piece of leather is not evenly distributed throughout its thickness. The grain section is the weakest part, showing only approximately 17 per cent. of the entire strength of the thickness. The centre portion possesses about one-third of the entire strength, while the remaining strength lies in the flesh.

Causes of Faults in Belt Drives

The following remarks may be useful in tracing faults in belt transmission. If the ply separates it shows the belt is too thick for the diameter of the pulley. Leather cracked on the outside and the joints opened up indicates the same cause, or that the tension is too great. If the belt is burned it shows that one pulley is rotating inside the belt, or in other words, bad slipping, which results in the pulley surface of the belt being glazed and cracked. If the belt curls and the plies open on the edge, it is either running against flanges or shifting forks. If the outside points of joints open up it shows the belt is being run in the wrong direction. Dry rot shows a lack of dressing. If it breaks through the endless joint it indicates improper cementing when installed. If the belt is torn in two it must have been struck on the edge by some object, or something dropped into it. Although a 12-in. heavy double requires 16,000 lbs. to break it under a straight pull, only 200 lbs. will tear it. The pulley would break before the belt would break in two. An unduly short life of leather and cement shows that the belt is too small for the horse-power.

(*Continued in next column.*)

The Foundryman and the Metallurgist

(*Continued from page 42.*)

case. It was a matter of a man maintaining his position, and undertaking a job for which he had been trained. No foundryman, as such, knew everything there was to be known about foundry work, and secretiveness would inevitably mean stagnation. Publicity and confidence induced progress. Personally, he was receiving much more assistance from the discussion than he had hoped for. Views were being expressed which would be of permanent use to everyone in the industry when they were published.

MR. COOK hoped that neither Mr. Fleming nor anyone else had taken his remarks as intended to be derogatory to the metallurgist. Mr. Dunleavy had seemed to infer that once a metallurgist was engaged the foundryman's troubles were at an end. His own point, which he was actually endeavouring to impress upon the minds of his hearers, was that they must all work together. The metallurgist must prove to be of very great assistance, and was at the present time actually of very great assistance to the foundry manager; but the foundry manager himself must carry the ultimate responsibility. The metallurgist was necessary; but the fact of having a metallurgist, or anyone else, in the foundry, did not make it certain that there would be good castings. It was from the metallurgist's report that a clue was obtained in regard to the question of raw materials.

Metallic Losses

MR. E. J. L. HOWARD thought Mr. Dunleavy had made out a sound case for the metallurgist in the foundry. He agreed with Mr. Brooks that much depended upon the size of the foundry as to whether a whole-time metallurgist was necessary. In the case of a large engineering works which included a foundry, it was worth while because the metallurgist's duties were not confined merely to the foundry itself.

The idea that there was much secrecy in regard to the work of the metallurgist could be disproved by reading the proceedings of the various technical associations, in which new methods of working were clearly described and reports were published also of investigations into failures and breakdowns.

Mr. Dunleavy had spoken of rotary furnaces and gassed metal. What type of oil was being used, and what was the lining? Mention had also been made of eight mixings daily. Were eight mixings used in the two furnaces; if they were, what of the question of contamination? The metal loss of 2 per cent. seemed to be very low. Was Mr. Dunleavy using any of the zinc alloys?

MR. DUNLEAVY said that the point about the metallurgist not being entirely concerned with the foundry was one which he had deliberately ignored. The foundry was merely one department in the whole works, and the metallurgist was also concerned with heat-treatment and with the fairly large smiths' work. He was in the position of being almost a works advisor on raw materials, the foundry being just one particular line involved. His services were available whenever required.

The lining of the rotary furnaces was a proprietary refractory. The oil was a light fuel oil, probably nearly all paraffin. It was now being suggested that creosote should be used. The metal loss was definitely 2 per cent.

Gunmetal Impellers

With regard to the mixings, care was taken to drain after every melt. There was a slight contamination. The only high-zinc alloy used was melted in a crucible by itself, and a separate crucible was kept for Monel, ensuring no risk of contamination. The first experience of Monel was an impeller similar to the type shown in Figs. 3 and 4, in which the main job was coring. It was a very difficult job done in segments. Admiralty gunmetal (88:10:2) was melted in a crucible. Three were made before a sound one was obtained. The first one was cracked, on being left overnight, in seven or eight pieces. The second one was left for a time to cool, but it cracked while still a bright red. It was then realised that the difficulty was something beyond the control of the foundry, and they could now say with 99 per cent. certainty that a casting would be sound.

Mr. Dunleavy concluded by remarking that once a report had been received from the metallurgist concerning a particular problem, it was usually easy for the foundryman to deal with it.

(*Continued from previous column.*)

Belt Dressings

In conclusion, the value of a good belt dressing must be stressed. Here the author would stress that he has no axe to grind; he is simply speaking from the point of view of the user. Prejudice has existed against dressings generally, because in the past some of them had a detrimental effect on the life of a belt. Such progress has been made, however, in the production of belt dressings which actually preserve the belting to which they are applied that except in special cases, such as in the food trades, where it is essential to remove any possibility of foreign matter like oil or dressing damaging the product of manufacture, there are no valid reasons why dressings should not be used. The efficiency of the belt transmission is increased by the "feeding" of the belt to the pulleys and the preservation of the leather. Good belt dressing, in fact, is to a belt what good lubrication is to a bearing, and if bearings are worth proper treatment by lubricating so also are belts worth proper treatment by dressing.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

525,192 HENLEY EXTRUSION MACHINE COMPANY, LIMITED (in liquidation), DUNSHEATH, P., and GRIFFITHS, F. T. Electrically-heated tubular melting furnaces.

528,284 DONALD, G. H. Gas-producer for use with solid fuels such as wood, peat, straw, and the like.

525,197 LOMBARD, J. M. L. Heat recuperator for heating air for combustion.

525,204 STEIN & ATKINSON, LIMITED (Surface Combustion Corporation). Furnaces, particularly for the heat-treatment of metals.

525,223 LINDEMUTH, L. B. Casting steel ingots.

525,238 OSTERREICHISCHE MAGNESIT AKT.-GES. Mortarless furnace brickwork.

525,364 BAIER, S. W., and MACNAUGHTAN, D. I. Process and apparatus for the electrodeposition of tin alloys.

525,430 METALLGES. AKT.-GES. Furnace plant for melting and refining metals and metallurgical products.

525,478 GENERAL MOTOR CORPORATION. Manufacture of malleable iron.

525,513 BIRMINGHAM ELECTRIC FURNACES, LIMITED, ROBIETTE, A. G. E., and HANCOCK, P. F. Heat-resistant parts of furnaces.

525,568 BIRMINGHAM ELECTRIC FURNACES, LIMITED, and ROBIETTE, A. G. E. Electric furnaces.

525,591 BRASSERT & COMPANY, LIMITED, H. A. Manufacture of steel by the basic Bessemer process.

Improving Core-making Methods*

By LEROY P. ROBINSON

Some 20 years of close contact with the core shops of America has indicated, among other things, that failure to produce good cores generally can be attributed to one or more of nine fundamental factors. Obviously, it would be impossible within the scope of this article to do more than touch upon these fundamental causes. A brief reference to each item may serve to point out some inherent defects in core shop operation.

While it is a fact that cores can be made from practically any sand, there is always one best kind of sand for any particular core and any particular metal, grey iron, steel, malleable or non-ferrous. Through locality or cost, the ideal sand is not always available. However, each section of the country has some sands superior to others, and the cost is not prohibitive. When used in the proper ratios with binders, these sands can, and do, produce commercial cores.

Proper Selection of Sands

Generally speaking, core sand should be chosen on the following basis: (1) Sand must be reasonably clean. An excess of clay content or fines forces the coremaker to use too much oil to produce a strong core with sharp edges. Too much oil generates an excess amount of gas, and if this gas is not driven out of the core during baking, it surely will increase the possibilities of blows in pouring. (2) Sand must be uniform in grain size, and it should be remembered that the smaller the grains, the more oil required to cover the larger surface area. Angular or sub-angular grains are preferable to round grains. (3) Sand must be open enough to allow free passage of gas. This factor is controlled largely by the two preceding points. (4) Sand must be sufficiently refractory to withstand the action of metal. Different metals vary to a considerable extent in their effect on cores, and that always must be considered.

Choice of Binder

Many types and kinds of binders are available, and most of them may be said to have some value within rather strict limitations. A book could be written on a comparison of these binders. Since the advent of the internal-combustion engine and the resulting necessity for production of highly intricate cores, it has been recognised generally that core oils have extremely valuable properties. While there are some exceptions to the rule, it is the author's opinion that any core, not too large to be baked overnight, should be made in oil sand.

In selecting an oil, care should be taken to choose one which will give:—(1) Free workability in the core boxes, since modern foundry practice usually puts a piece-price on the production of cores; (2) reasonably quick baking to save fuel costs and permit of a maximum number of cycles through the ovens; (3) maximum binding strength. It is well known that the less oil used in a core, providing it is a commercial core, the better will be results in core oven, moulds and cleaning room.

Cereal Binders

While on the subject of binders, it may be appropriate to touch briefly on cereal binders. There seems to be a tremendous amount of misinformation on their place and use. No foundry should be without cereal binders. They serve a distinct purpose in supplying green bond, particularly in core-blowing machines. However, the common tendency is to use too much cereal binder. A safe plan is to use just sufficient to give the required green bond strength.

Corect Ratio of Oil to Sand

Many foundrymen fail to recognise the importance of using a definite ratio of oil to sand and then keeping to that ratio. It is a mystery how some foundries get along as well as they do when they fail to measure either oil or sand, or just guess at the amounts. Foundrymen may pay especial attention to moulding sand control or close analysis of the metal, but show an utter disregard toward this all-important point. The successful foundry sets up definite, predetermined mixtures for various jobs, and insists that a measured amount of oil is added to a measured amount of sand.

Mixing and Mulling

Considering all that has been said and written on the subject, one would imagine that every foundryman realises the necessity of coating each grain of sand with oil. Despite a knowledge of the proper method, many foundries mix sand by hand on the bench, on the floor with a shovel, or with some makeshift riddle arrangement. A mechanical mixer of the paddle or muller type easily will pay for itself in oil saved and uniformity of sand texture. Some foundries recognise the necessity of using mixers, but pay no attention to mixing time or the proper routine of adding oil, water and cereal binder. Extended investigation definitely has proved there is a proper time limit. Usually that time limit is much less than one would imagine. Some tests of mixing time should be made to ascertain just where the critical point occurs when core sand starts to lose its maximum tensile strength. This also applies to cereal-binder addition.

Control of Moisture Content

Failure to recognise the importance of moisture control probably is more responsible for lack of uniformity in cores than any one variable in core-shop operation. Inattention to that important item manifests itself in the following ways:—(1) Poor workability in the core box. Check the moisture content next time the coremakers complain about cores sticking in the boxes. (2) Slow drying in ovens. No oxidation possibly can take place until all moisture is driven from the cores. (3) Cracks and split cores, if accompanied by temperatures that are too high or a baking cycle that is too quick. (4) Haphazard ratios. Wet sand means less sand.

Foundries should start with dry sand to which should be added a predetermined amount of water. This is the only way to eliminate that variable. Lacking any definite moisture control, the moisture content of the core sand mixture should be kept between 3 per cent. and a maximum of 5 per cent. In core-blowing machines the moisture content of the sand should be kept down to 2 per cent. for best results. These recommendations refer particularly to lake sands in common use in the Mid-West, but experiments can determine the proper moisture content of any sand.

Proper Baking

When a housewife bakes bread, she does not put the dough in the oven and say, "There, now, that's got to be out in 15 minutes." Yet some foundrymen seem to feel that they can spare only so much time for a certain core. The fact of the matter is that a core should not be rushed, nor should it be brought out of the oven just because it is the shape of the core. Cores pulled out of the oven with a nice, nut-brown colour will give no trouble. Overbaking results in cuts, washes and broken cores. Underbaking produces blows and smoke.

To bake cores properly and uniformly:—(1) Install a pyrometer on the ovens or wipe the dust off the pyrometer placed on the oven years ago, but not used lately. (2) Set a temperature of 200 deg. C. and maintain it. (3) Bake the cores at that temperature and remove them when they are nut-brown. (4) Do not pull out a white-centred core. (5) Do not leave a core in until it is black. This colour indicates over-oxidation and loss of film value. (6) Acquire proper core ovens from a manufacturer who has put in a lifetime of study on the subject. He will supply an oven that will not be filled with hot and cold spots, and that will not produce half-dried or burned cores because the wind shifted to the west. (7) Clean out the oven flues once in a while.

Proper Venting

Surely it should not be necessary to mention this feature, yet it is overlooked every day. If there is any reason for putting a vent in a core, there is further reason for seeing that the vent passages are not stopped. See that cores are properly vented and then follow through into the foundry to ascertain that the moulders provide proper outlets. Make sure that coremaker and moulder use vents of sufficient size.

Proper Inspection

Some coremakers seem to feel that their one job is to make cores, whereas the only function of a foundry is to produce good castings. If a core is useless, it should be thrown away. An exceptionally successful foreman coremaker made the statement that a casting never should be lost on account of a core. His belief was predicated on core inspection and more inspection. This means additional labour cost, but without doubt it will pay big dividends. The great motor-vehicle and other speciality shops making millions of cores actually operate their foundries with lower casting loss than many smaller shops, and the answer is proper inspection.

* *Résumé* of an address given before several Chapters of the American Foundrymen's Association. The author is director of core-oil sales, The Werner G. Smith Company (Division of Archer-Daniels-Midland Company), Cleveland, Ohio.

Co-operation in Export Marketing

Mr. L. G. Adams, in an address on "Group Selling Oversea" at a meeting of the Institute of Export last week, said that the intense competition brought about as the result of the last war, coupled with the extensive development of secondary industries now taking place as the result of the present war, meant that if our export trade was to survive careful study must be given as to every possible method that could help capture and retain the oversea markets. Co-operative selling meant the banding together of four or five firms selling similar, but non-competitive, articles to the same class of buyer. As the goods sold by the group would be to the same buyer it would be possible to share equally costs of market research, advertising, and propaganda, and, where necessary, the establishment of showrooms in the more important markets. Thus it would be possible for the average manufacturer to have an efficient export organisation with almost world-wide ramifications at a fraction of the normal cost. Many manufacturers were to-day looking to the Government export groups for expert guidance.

AN ORDER has been made by the Board of Trade under the Trading with the Enemy Act, 1939, and Defence (Trading with the Enemy) Regulations, 1940, requiring Minerals & Metal Scrap, Limited, 11, Queen Victoria Street, London, E.C.4, to be wound up. The controller is Mr. A. Stuart Allen, 36, New Broad Street, E.C.2.

The Week's News in Brief

Trade Talk

WHYMAN'S FOUNDRY COMPANY, LIMITED, has been elected to membership of Warrington Chamber of Commerce.

CONCRETE, LIMITED, of Stourton, Leeds, 10, have issued a short history of the firm to celebrate their coming-of-age.

EMPLOYEES of Sir William Arrol & Company, Limited, Glasgow, contributed £944 to Glasgow and West of Scotland charitable institutions during 1940. Dalmarnock Ironworks subscribed £658, and the Parkhead Crane Works £286.

A MESSAGE from Melbourne states that the Commonwealth Government has approved the application of the Broken Hill Proprietary Company, Limited, for an issue of 2,500,000 shares of £1 for shipbuilding, munitions and other war work.

MR. W. W. HACKETT, a director of Accles & Pollock, Limited, tube manufacturers, of Oldbury, has received a cable from the Service Steel Company, of Detroit, U.S.A., which reads: In Christmas remembrance of you and other Oldbury friends, we have to-day contributed 5,000 dollars to British war relief.

THE BRITISH RHEOLOGISTS' CLUB (which concerns itself with the flow and deformation properties of materials), has held its inaugural meeting at the University of Reading. The meeting was remarkably well attended by members from all parts of the country. The need for such a club was thereby amply demonstrated. Prof. J. A. Crowther, Professor of Physics in the University, presided. The morning session was devoted to a discussion of "Rheology in Industry," the opening speakers being Mr. J. Pryce Jones and Mr. F. D. Farrow. This opportunity for an exchange of views and for gaining a knowledge of new instruments was welcomed by all who attended the meeting. Prof. G. I. Taylor is President of the Club and Dr. G. W. Scott Blair the secretary. The address is c/o The Institute of Physics, The University, Reading, Berks.

THE BOARD OF TRADE draw the attention of manufacturers of machinery, plant and appliances, and those wishing to acquire them, to an amendment in the Statutory Rules and Orders governing the sale or transfer of machinery and to extension of the Orders to include additional machinery, plant and certain appliances. The new Order—the Machinery, Plant and Appliances (Control) Order (S.R. & O. 1940, No. 2179)—came into force on January 1. It amends the Machinery and Plant (Control) Order (S.R. & O. 1940, No. 875) and Machinery and Plant (Control) (No. 2) Order (S.R. & O. 1940, No. 1363). Copies of the Orders, price 1d. each, are obtainable from the Stationery Office. Any person wishing to acquire machinery, etc., must obtain a supply licence, and manufacturers should not book orders until they know that the person to be supplied has obtained the necessary licence. Application forms for licences can be obtained from the Industrial Supplies Department, Machinery Licences Division, Board of Trade, 25, Southampton Buildings, London, W.C.2.

THE MINISTER OF FOOD has made an Order under the Defence Regulations, entitled the Starch and Dextrine (Control) Order, 1940, which covers all forms of starch, whether made from maize, potatoes, rice, rye or wheat, and of starch and flour made from sago or tapioca, including cassava, manioc and mandioca. Dextrine is defined as including soluble starch and British gum. The Order does not affect maize flour ("corn flour" is starch and comes under the provisions of the Order); rice flour and ground rice, and edible sago and tapioca, arrowroot. The Order took effect on January 6, and as from that date a permit will be required for all wholesale transactions in starch or dextrine. Machinery has already been set up for the control of imports and manufacture of starch and dextrine, and for the issue of permits through the various Government Controls and trade organisations appropriate to the various manufacturing uses of starch and dextrine. So far as foundry supplies are concerned, applications should be made to the Foundry Trades' Equipment and Supplies Association, 52, Surbiton Hill Park, Surbiton, Surrey.

Personal

MAJOR-GENERAL A. E. DAVIDSON has joined the local board of the Vulcan Foundry, Limited, Newton-le-Willows, Lancs.

MR. E. L. BAER has been elected chairman of Metal Traders, Limited, in place of the late Lord Abertay. Mr. Baer has also been appointed managing director of the company.

MR. F. SOMERS, a director of Walter Somers, Limited, Heywood Forge, Halesowen, and members of his family, are giving a mobile canteen for the use of the borough.

LT.-COL. LORD DUDLEY GORDON, president of the Federation of British Industries, has been nominated for a second year of office. He is chairman of J. & E. Hall, Limited, engineers, of Dartford.

MR. R. HUNTER, chief engineer of the Burntisland Works of the British Aluminium Company, Limited, has retired under the firm's superannuation scheme. The staff and his own engineering department have made presentations to him.

MR. WALTER TWEEDALE, who retired last October from the position of managing director of Tweedales & Smalley (1920), Limited, textile machinists and ironfounders, after 49 years' connection with the firm, received a presentation on December 31. Mr. Tweedale remains chairman of directors.

MR. ALLAN J. GRANT, whose name appeared in the New Year's Honours List as the recipient of a knighthood, was knighted by the King when His Majesty visited the factory of Thomas Firth & John Brown, Limited, last week. Mr. Grant is managing director of the company and he was knighted in the presence of hundreds of cheering workpeople—the first time, it is believed, that the accolade has ever been conferred in a factory.

Wills

BESSEKER, HENRY, of Exmouth, retired brass and bell founder	£39,388
DAVY, C. S., late chairman of the Calorizing Corporation of Great Britain, Limited, and late a director of Babcock & Wilcox, Limited	£13,788

Obituary

MR. WILLIAM OATES, a former managing director of the Leeds Fireclay Company, Limited, died at his home in Chester at the age of 75.

MR. NORMAN CHURCHILL, who founded the Churchill Foundry, Darwen, over 50 years ago, and was sole proprietor for nearly 40 years, has died, aged 82.

MR. JAMES EDWIN COULTHURST, who was for 20 years associated with H. J. & A. Coulthurst, Limited, engineers and ironfounders, of Darwen, died recently at the age of 67 years.

MR. ALFRED J. STARKEY, aged 80 years, for 40 years proprietor of the Bridge Foundry, Warrington, has died. He was also for a number of years in partnership with his brother, the late Mr. E. W. Starkey, as a hardware dealer in Warrington.

MR. W. F. WARDLEY, an outstanding figure in the industrial and civic life of Sheffield, has died at the age of 92. Secretary of the Cutlery Union from 1915 to 1924, and before that of the Sheffield Table Blade Forgers' and Strikers' Union, he was the city's first Labour Lord Mayor. An Alderman, he completed 50 years' unbroken service on Sheffield City Council on November 1 last.

MR. ROBERT BRADLEY SUMMERSON, chairman of Thomas Summerson & Sons, Limited, railway plant manufacturers, of Darlington, died on January 3, aged 84. The firm was founded by his father over 70 years ago. Mr. Summerson was for 16 years a member of the Darlington Rural Council, and for the past seven years had been a county magistrate.

WE REGRET to announce the sudden death on Wednesday, January 8, of Mr. John White Hampsheir, director and general manager of Keith Blackman, Limited, of London and Arbroath. Mr. Hampsheir, who was 71 years of age, joined the company in 1892 and became secretary in 1905. He was elected to the board in 1921, and appointed general manager four years later. He served the company with conspicuous ability, and the directors feel keenly the loss of their colleague.

MR. LAUCHLAN PATERSON MACKENZIE, chairman of Mackenzie & Moncur, Limited, ironfounders and heating engineers, of Edinburgh, died recently. In 1904 he joined in business with his brother, Mr. Cossar Mackenzie, who was then proprietor of the original ironfounding business in Gilmour Park, which was afterwards extended to Gorgie. After the death of Mr. Cossar Mackenzie, the business was further developed, and was later amalgamated with the firm of Mackenzie & Moncur, heating engineers. Mr. Mackenzie was 70 years of age.

Reports and Dividends

Greenwood & Batley, Limited—Interim dividend on the ordinary shares of 5 per cent. on account of the year ending March 31 next.

Turner & Newall, Limited—Profit for the year to September 30, £2,136,726; brought in, £66,763; depreciation, £188,796; income tax, N.D.C. and/or E.P.T., £929,966; net profit, £1,015,214; preference dividend, £101,098; to general reserve, £100,000; Welfare Trust, £10,000; ordinary dividend of 15 per cent.; carried forward, £71,515.

Ley's Foundries & Engineering, Limited—Combined trading profit of the company and its subsidiaries for the year to September 30, £281,502; net profit, £69,671; net profit of the parent company, £65,385; brought in, £23,474; final dividend of 5 per cent. on the ordinary stock, making 11 per cent. for the year; carried forward, £39,484.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Sibor Hard Metals (London), Limited, Imperial House, Dominion Street, London, E.C.2—Capital, £1,000. Directors: Lord Strabolgi, Sir Samuel Chapman, M.P., and L. Rabinovitch.

A. T. Halhead & Company, Limited, Phœnix Works, Birmingham Road, Wolverhampton—Capital, £1,000. Machine and press tool makers, etc. Directors: J. A., C. H., G. F., and J. E. Onions.

Brimscombe Foundry, Limited, Golden Valley Works, Brimscombe, Glos—Capital, £2,000. To take over the business carried on as "John Cousins & Company," at Brimscombe. Directors: J. Cousins, A. S. Bullock and C. T. R. Shepheard.

Contracts Open

London, S.W., January 30—Castings, etc., for periods of six and twelve months from March 31, for the Lambeth Borough Council. Mr. G. H. Buckett, Brixton Hill, London, S.W.2.

Selby, February 17—Cast-iron grates and frames for the year ending March 31, 1942, for the Rural District Council. Mr. Richard F. Braithwaite, 22, Park Street, Selby, Yorks.

Stockport, January 25—Cast-iron pipes and specials; lead (gas and water) piping; tubing and fittings; brass fittings; pig-lead; oxide of iron; flexible connectors and tubing, for 12 months ending March 31, 1942, for the Town Council. The Secretary, Gas Department, Town Hall Annexe, Stockport.

Carrick-on-Shannon, February 7—Supply and erection of three pumping units, including electric motors and automatic switchgear, for Leitrim Board of Health and Public Assistance. Mr. P. J. Haugh, county engineer, Courthouse, Carrick-on-Shannon. (Fee £5 5s., returnable.)

Forthcoming Events

JANUARY 20.

Royal Society of Arts:—"Influence of Art on Instruments of War," the first of three Cantor Lectures, by James G. Mann, in London, at 1.45 p.m.

JANUARY 24.

Institution of Mechanical Engineers:—"Progress in Marine Engineering as Affected by the Classification of Ships," Thomas Lowe Gray Lecture, by Dr. S. F. Dorey, in London.

JANUARY 25.

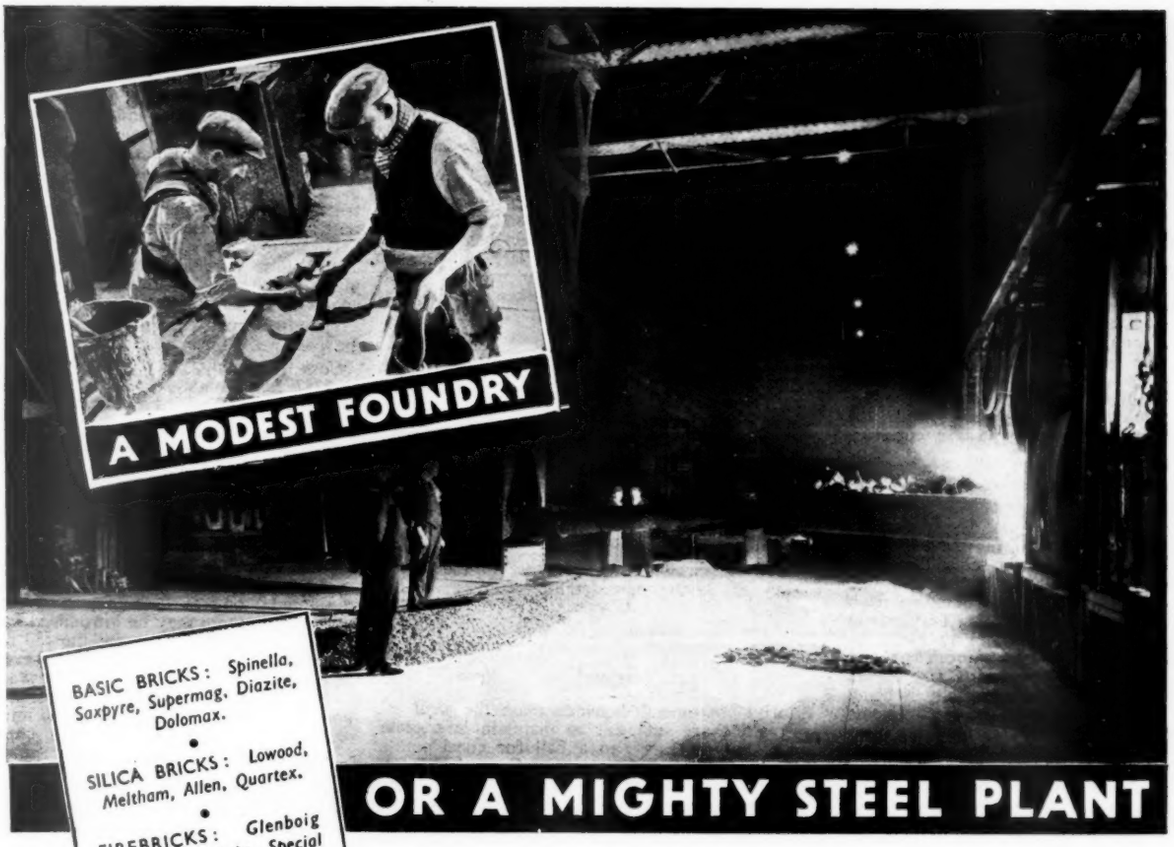
Manchester Association of Engineers:—"Recent Engineering Applications of Non-Ferrous Metals and Alloys," Paper by F. Hudson, in Manchester, at 2.30 p.m.

Institute of British Foundrymen

JANUARY 25.

East Midlands Branch:—"Coreshop Production Costs." Paper by N. P. Newman, at Derby.

Middlesbrough Branch:—"Production of Engineering Castings in the Light-Castings Industry," Paper by T. Tyrie, at Middlesbrough, at 3 p.m.



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•

CEMENTS: Sintex, Durax, Pyrolyte.

•

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•

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Raw Material Markets

Ever-increasing demands upon iron and steel makers are being made by various Government defence measures, and outputs are fully booked up and distributed, according to the orders of the Iron and Steel Control. Makers now, of course, have no obligations, outside producing maximum outputs, apart from despatching licensed supplies to selected consumers, all business being conducted in this way. It can be said that all priority users are being kept supplied with sufficient material to enable them to operate without interruption, but some other iron and steel consumers are less favourably placed, as the satisfaction of essential orders is only possible even now with the assistance of material bought overseas, and it is obviously imperative to restrict importations as far as is practicable. Large supplies are available abroad, but the necessity for conserving shipping space for other purposes is very important, while the question of foreign exchange also has a considerable bearing on the subject.

Pig-Iron

MIDDLESBROUGH—Many foundrymen are using larger tonnages of cast-iron scrap than ever before in order to lessen their consumption of foundry iron, which now has to be obtained from the Midlands, Cleveland makers being engaged on the production of iron for steelmaking purposes. Derbyshire and Northamptonshire producers are catering for the needs of North-East Coast buyers satisfactorily, but their productive capacity is being taxed, as, in addition to meeting the requirements of Midlands and Cleveland users, they are also called upon to despatch supplies to other areas, including Scotland. Priority consumers here are receiving all that is necessary to cope with their orders, but there is not much iron to spare and stocks are of small extent.

A fair tonnage of United States hematite iron is being used in this district, as local output is completely disposed of under licence. Certain hematite users are able to incorporate high-phosphorus iron in their mixtures, which is all to the good, as this type of iron is the product of home-produced ores, and is available in fairly large tonnages. Consideration in the allocation of hematite is given first, of course, to works engaged on contracts connected with the war effort, and many of these concerns are making heavier demands for hematites of special analysis.

LANCASHIRE—Several jobbing foundries continue to report slacker conditions, while the light-castings trade is still not fully employed, but the pressure on ironmakers from consumers in this area remains insistent, and the aggregate consumption is impressive. Jobbing foundries are expecting better order-books at an early date, and those connected with speciality engineering concerns are already working at high pressure. Heavy engineers have been engaged on orders for Government departments, either directly or indirectly, for a long time past, and there is every indication that they will continue to play a major part in the satisfaction of official requirements in the future, as replacement orders are available as fast as contracts are completed. The hematite position shows little change, supplies being limited and distribution made to essential consumers.

MIDLANDS—Consumption of high-phosphorus iron is rising week by week, most of the additional material being taken up by makers of light castings, who are now quite active in many instances. Especially is this the case where works have been able to adapt their plant to cope with Government needs. Builders' merchants, too, are calling for larger supplies of various castings, so that the situation in the trade is greatly improved. High-phosphorus iron is being delivered to users satisfactorily, but this is hardly true of low-phosphorus iron and hematite, used in the main by heavy engineering works. Hematite is being imported to rectify the position caused by insufficient home-produced material, so that, in the interests of economy, considerable watchfulness has to be exercised in distribution. Where possible, users are being urged to substitute other irons, and this is being successfully carried out in a large number of instances.

SCOTLAND—Some pig-iron consuming works were idle for a short time early in the new year in order to facilitate repairs, which were necessary after a long period of continuous operations, but these were carried out extremely quickly, and the time lost was negligible. Heavy engineers are in possession of full order-books, as they have been for a long time past, and there is no reason to anticipate any change in these conditions. Business among makers of light castings has improved to a pronounced extent of late, but some foundries are still seeking further orders. Steel-making irons continue to be taken up in very substantial tonnages.

Coke

As reported in our last issue, prices of foundry coke have been further advanced, the latest increase being one of 1s. per ton, making the current f.o.t. quotation for Durham best coke 45s. 6d. per ton. It will be recalled that prices were raised last month by 2s. 6d. per ton. There is still a certain amount of delay in getting supplies through to consumers, but ample tonnages are available at the ovens, while most users are in the happy position of having considerable reserves on the ground.

Steel

Priority consumers' demands upon the steel industry alone are sufficient to maintain large-scale outputs, but there is also a call for considerable supplies from other sources. The Control authorities thus find no difficulty whatsoever in disposing of all the steel produced and are, in fact, forced to make large purchases of foreign material, which is naturally more expensive, although imported steel is sold to buyers here at the same quotations as those charged for British steel, the difference being covered by the central fund set up for financing imports. In addition to the demands made upon ordinary qualities, there is an expanding call for special steels, used in the manufacture of munitions, etc.

Scrap

There is a steady outlet for iron and steel scrap, but all needs can be met, as the supply situation continues to be satisfactory. While consumption is undoubtedly heavy, fresh scrap metal is forthcoming, and some consumers have been able to lay down appreciable stocks, in addition to the dumps built up under official guidance. Foundrymen are particularly well placed as regards their scrap requirements, deliveries coming to hand freely.

Metals

The International Tin Committee will meet in London on March 20, when it is expected that the question of the continuance of the restriction scheme beyond the end of 1941 will be fully discussed. The scheme is scheduled to end this year, but it seems fairly certain that it will be renewed, although certain adjustments may be made in the existing conditions. For example, the Netherlands East Indies, Nigeria, the Belgian Congo and Malaya are eager to co-operate for restriction, but they hold the view that a revision of their standard tonnages should be made. Bolivia, on the other hand, is understood to be satisfied with the present scheme and anxious for its continuance at least until the end of next year. The renewal of the scheme must be considered by the I.T.C. during this quarter under the terms of the scheme and, should agreement be reached, the Governments concerned must announce their decision regarding the Committee's proposals not later than September 30 next.

Business in tin in London has remained rather restricted, with prices steady. A moderate trade is reported from the United States. America appears to be willing to take as much Chinese tin as is offered her; in addition to desiring to acquire this metal as a reserve stock contribution, it is believed that the policy was formulated by the desire to assist the Chinese financial situation. In any case, a large proportion of the Chinese metal is probably going straight into industrial use, as the tin is mainly common metal, whereas the Metals Reserve Company is buying refined tin elsewhere. According to the American Bureau of Metal Statistics, consumption of tin in the United States for the ten months to October 31 last amounted to 61,620 tons, and deliveries totalled 93,634 tons. It is believed that the greater part of the balance of 32,000 tons was taken up by private users and placed into stock, while some of the metal was acquired by the Metals Reserve Company.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £256 15s. to £257; Friday, £257 to £257 5s.; Monday, £256 15s. to £257; Tuesday, £256 15s. to £257; Wednesday, £256 15s. to £257.

Three Months—Thursday, £259 15s. to £260; Friday, £259 15s. to £260; Monday, £259 10s. to £259 15s.; Tuesday, £259 10s. to £259 15s.; Wednesday, £259 5s. to £259 10s.

Although large supplies of copper are available, the Control authorities are exercising great care with regard to distribution, so that no inconvenience shall be caused to priority users, whose consumption in the aggregate represents a very substantial tonnage. A report from America suggests that there may be introduced in the U.S.A. a scheme of priority uses for the red metal in the domestic market. It is further believed that the Metals Reserve Company may release during February some of the copper it holds as a reserve. Japan is understood to be paying as much as 12.50 cents per lb. f.a.s. for American copper, which is considerably in excess of the general export quotation. The Soviet Union, which has previously imported little copper from the United States, was its third best customer in 1940, having purchased 54,478 short tons during the year.

According to the American Copper Institute, United States copper statistics for December compare with November as follow:—Crude production, 84,937 (84,283) tons; refined production, 97,035 (96,283); deliveries to U.S. consumers, 112,671 (102,483); export shipments, 10 (nil); refined stocks at end of month, 142,772 (158,418).

The zinc position in the United Kingdom remains unchanged, with priority consumers taking up the bulk of the available supply. Allocations in other directions are being made very carefully. No shortage of the metal is expected to be met for essential purposes in the United States during 1941; producers there anticipate a monthly output of between 70,000 and 75,000 short tons of all grades. Ample supplies of lead are being supplied to meet British war requirements, and other uses are also well supplied.